

**DEPARTMENT OF WILDLIFE ECOLOGY and
MAINE COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT**

5755 Nutting Hall
University of Maine
Orono, Maine 04469-5755

UNIT COOPERATORS *

UNIVERSITY OF MAINE

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

BIOLOGICAL RESOURCES DIVISION, U.S. GEOLOGICAL SURVEY

WILDLIFE MANAGEMENT INSTITUTE

October 1999 - September 2000

Compiled and Edited by
William B. Krohn and John R. Moring

This report details the research objectives, procedures, and findings of numerous investigators. Since data contained may be preliminary and inconclusive, permission to reproduce or publish any of the contents of this report in any way is withheld pending specific authorization from the Unit Leader and Chair, Department of Wildlife Ecology.

*The Unit's Fisheries Program is located in 313 Murray Hall and is within the Department of Biological Sciences, College of Natural Sciences, Forestry, and Agriculture; the Unit's Wildlife Program is located in 210 Nutting Hall and is co-located with the Department of Wildlife Ecology, College of Natural Sciences, Forestry, and Agriculture.

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PERSONNEL AND COOPERATORS

COORDINATING COMMITTEE

Maine Department of Inland Fisheries and Wildlife
Lee Perry, Commissioner

University of Maine

James R. Gilbert, Chairperson, Department of Wildlife Ecology, College of Natural Sciences,
Forestry, and Agriculture

Christopher S. Campbell, Chairperson, Department of Biological Sciences, College of Natural Sciences
Forestry, and Agriculture

USGS Biological Resources Division

Michael W. Tome, Supervisor, Cooperative Research Units

Wildlife Management Institute

Scot J. Williamson, Northeastern Representative

UNIT PERSONNEL

Unit Staff:

William B. Krohn, Unit Leader, Professor of Wildlife Ecology and Cooperating Professor of Zoology

John R. Moring, Assistant Unit Leader for Fisheries, Professor of Zoology
 Cynthia F. Loftin, Assistant Unit Leader for Wildlife and Assistant Professor of Wildlife Ecology
 Susan Anderson, Unit and USGS-LSC Administrative Assistant - Fisheries
 Nora Ackley, Unit Administrative Assistant II - Wildlife Ecology
 Theresa Libby, Secretary - Wildlife Ecology

Associated Faculty and Staff, Departments of Wildlife Ecology and Biological Sciences:

James R. Gilbert, Chairperson, Department of Wildlife Ecology, College of Natural Sciences, Forestry, and Agriculture, and Professor of Wildlife Ecology
 Christopher S. Campbell, Chairperson, Department of Biological Sciences, College of Natural Sciences, Forestry and Agriculture, and Professor of Plant Systems
 William E. Glanz, Associate Professor of Zoology and Cooperating Associate Professor of Wildlife Ecology
 Kevin J. Boyle, Associate Professor, Department of Agriculture and Resource Economics, and Cooperating Associate Professor of Wildlife Ecology
 Michael S. Bank, Instructor, Department of Wildlife Ecology
 Susan Gerken, Research Associate, Wildlife Ecology
 Daniel J. Harrison, Associate Professor of Wildlife Ecology
 Jeff Hepinstall, Scientist, Wildlife Ecology
 Malcolm L. Hunter, Jr., Professor of Wildlife Ecology
 Allan O'Connell, Faculty Associate and Leader, Cooperative National Park Unit, USGS
 Raymond J. O'Connor, Professor of Wildlife Ecology
 Frederick A. Servello, Associate Professor of Wildlife Ecology
 Judith Rhymer, Assistant Professor of Wildlife Ecology
 Jerry R. Longcore, Faculty Associate, Wildlife, and Research Wildlife Biologist, USGS
 Terry A. Haines, Professor of Zoology and Fishery Research Biologist, USGS
 Jack Witham, Assistant Scientist, Wildlife Ecology

Maine Department of Inland Fisheries and Wildlife:

Lee E. Perry, Commissioner
 Frederick B. Hurley, Jr., Deputy Commissioner
 Kenneth D. Elowe, Director, Bureau of Resource Management
 G. Mark Stadler, Director, Wildlife Division
 Peter M. Bourque, Director, Fisheries and Hatcheries Division
 George J. Matula, Jr., Supervisor, Wildlife Resource Assessment Group
 Eugene A. Dumont, Supervisor, Regional Wildlife Management Section
 Kendall Warner, Supervisor, Fisheries Research and Management Section

GRADUATE STUDENTS

Name	Degree Candidacy	Support
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Sarah C. Billig	M.S.	MCCS,McIntire-Stennis, PCTC
Steven P. Campbell	Ph.D.	McIntire-Stennis
Bradley W. Compton	M.S.	U of M, MDIFW, McIntire-Stennis, USFWS
Carol R. Foss	Ph.D.	USFS, USFWS, SEFP
Angela K. Fuller	M.S.	MDC
Emily W. Gaenzle	M.S.	MDIFW, U of M
Merry Gallagher	Ph.D.	MDMR, MDIFW
Andrew T. Gilbert	M.S.	MDIFW, USFWS, McIntire-Stennis
Anne D. Guerry	M.S.	U of M
Nikolina Guldager	M.S.	NMFS
Amy Gullo	M.S.	U of M, NPS
Mitschka J. Hartley	Ph.D.	McIntire-Stennis
Brian J. Hearn	Ph.D.	Canadian Forest Service
Tara Henrichon	M.S.	USGS-BRD
Thomas A. Hoffman	M.S.	MDIFW
Jessica A. Homyack	M.S.	MCFRU, NCASI, USFWS
Christopher L. Hoving	M.S.	NCASI, USFWS, MDIFW, WCS
Jon B. Lê	M.S.	NPS
Nathan G. Leaman	M.S.	MDMR
Jennifer M. Lowry	M.S.	U of M
Marcy Lucas	M.S.	MDMR
Dawn L. Nelson	Ph.D.	HWRF
Stephanie L. Orndorff	M.S.	MOHF, MCFWRU
David C. Payer	Ph.D.	MDIFW, CFRU, U of M, NCASI
Anne M. Perillo	M.S.	USFWS, USFS, MDIFW
Dustin Perkins	Ph.D.	MCS
Regina M. Purtell	M.W.C.	Personal Funding
Steven C. Renner	M.S.	COA, U of M
Teresa M. Sauer	M.S.	U of M
Sandra M. Schaefer	M.S.	BRD/GAP, MCFWRU
Shelley Spohr	M.S.	NWTF, WF, UM, CDEP
James Stahlnecker	M.S.	MDMR
Jennifer A. Stone	M.S.	NPS
Marcia L. B. Summers	M.S.	U of M
Amy S. Williams	M.S.	NMFS, NBS
Heather L. Ziel	M.S.	U of M

DISSERTATIONS AND THESES COMPLETED THIS PERIOD

Student	Degree Candidacy	Support
Bradley W. Compton	M.S.	U of M, MDIFW, McIntire-Stennis, USFWS
Angela K. Fuller	M.S.	MDC
Anne D. Guerry	M.S.	U of M
Thomas A. Hoffman	M.S.	MDIFW
Jon B. Lê	M.S.	NPS
Nathan G. Leaman	M.S.	MDMR
Glen H. Mittelhauser	M.S.	MOHF, NPS, MDIFW

Jennifer A. Stone	M.S.	NPS
Amy S. Williams	M.S.	NMFS, NBS
Heather L. Ziel	M.S.	U of M

PERSONNEL NOTES

JON BAO LÊ received his M.S. degree in Zoology and is employed by the U. S. Fish and Wildlife Service in Vancouver, Washington. **THOMAS HOFFMAN** received his M.S. degree in Zoology and is employed by a consulting company in Portland, Oregon. **JENNIFER STONE** received her M.S. degree in Zoology and is employed by the U. S. Fish and Wildlife Service in Vancouver, Washington. **NATE LEAMAN** received his M.S. degree in Zoology and was named Assistant Hockey Coach at Harvard University. **BRADLEY COMPTON** received his M. S. degree in Wildlife Ecology and is a research associate at the University of Massachusetts in Amherst, MA. **ANGELA FULLER** received her M. S. in Wildlife Ecology and is a research associate at the University of Maine in Orono, ME. **ANNE GUERRY** received her M.S. degree in Wildlife Ecology and is a Ph.D. student at Oregon State University working with Jane Lubchenco. **JEFF HEPINSTALL** completed working with **Bill Krohn** on GIS analysis and is now working on a marten habitat supply model under the supervision of **Dan Harrison**. **AMY WILLIAMS** received her M.S. degree in Wildlife Ecology and is employed by the National Marine Fisheries Service in Washington. **HEATHER ZIEL** received her M. S. degree in Wildlife Ecology and is currently a lab technician in the Department of Biological Sciences at the University of Maine, Orono. **JAMES STAHLNECKER** received his M. S. degree in Zoology and is a Regional Fisheries Biologist with the Maine Department of Inland Fisheries and Wildlife, Sidney, ME.

COLLABORATING AGENCIES AND ORGANIZATIONS

American Wildlife Research Foundation - AWRF
 Audubon Society of New Hampshire - ASNH
 Baldwin Foundation - BF
 Baxter State Park - BSP
 Boise Cascade - BC
 Bowater-Great Northern Paper, Inc. - BGNP
 Central Maine Power - CMP
 College of the Atlantic - COA
 Connecticut Department of Environmental Protection -
 Wildlife Division - CDW
 Cooper Ornithological Society - COS
 Holt Woodlands Research Foundation - HWRF
 Fort James Corporation - FJC
 Maine Association of Wetland Scientists - MAWS
 Maine Bureau of Public Lands - MBPL
 Maine Department of Conservation - MDC
 Maine Department of Environmental Protection - MDEP
 Maine Department of Inland Fisheries and Wildlife - MDIFW
 Maine Department of Marine Resources - MDMR
 Maine Forest Service - MFS
 Maine Geological Survey - MGS
 Maine Office of Geographic Information Systems - MOGIS

Maine Outdoor Heritage Fund - MOHF
 Manomet Center for Conservation Sciences - MCCS
 National Council of the Paper Industry for Air and Stream Quality Improvement - NCASI
 National Science Foundation - NSF
 National Wild Turkey Federation -
 Connecticut Chapter - CCNWTF
 New Hampshire Fish & Game Department - NHFG
 New Hampshire Department of Resources and Economic Development -
 Division of Forests and Lands - NHDFL
 Penobscot Valley Conservation Association - PVCA
 Plum Creek Timber Company - PCTC
 Seven Islands Land Company - SILC
 Switzer Environmental Fellowship Program - SEFP
 University of Maine - U of M
 Association of Graduate Students - AGS
 College of Natural Sciences, Forestry, and Agriculture
 Cooperative Forestry Research Unit - CFRU
 Department of Forest Management - DFMDepartment of Wildlife Ecology - DWE
 Forest Ecosystem Science - FES
 Maine Image Analysis Lab - MIAL
 McIntire-Stennis - MCS
 Maine Agricultural and Forest Experiment Station - MAFES
 U.S. Department of Agriculture - USDA
 Forest Service - USFS
 U.S. Department of Commerce
 National Marine Fisheries Service - NMFS
 U.S. Environmental Protection Agency - EPA
 U.S. Department of the Interior - USDI
 U.S. Fish and Wildlife Service - FWS
 Gulf of Maine Project - GMP
 Neotropical Migratory Bird Program - NMBP
 Northern Maine National Wildlife Refuge Complex - NMNWRC
 Partnerships for Wildlife - PW
 Petit Manan National Wildlife Refuge - PMNWR
 National Biological Service - NBS
 USGS Biological Resources Division - BRD
 Cooperative Park Studies Unit - CPSU
 Gap Analysis Program - GAP
 Leetown Science Center - LSC
 Maine Cooperative Fish and Wildlife Research Unit - MCFWRU
 National Park Service - NPS
 Acadia National Park - ANP
 Wagner Forest Management, Ltd. - WFM
 Wildlife Forever - WF

ENDANGERED AND THREATENED SPECIES:

**ECOLOGY AND CONSERVATION OF
THE WOOD TURTLE (*Clemmys insculpta*) IN MAINE**

- Investigator:* B. W. Compton
- Advisors:* J. M. Rhymer, Chairperson
M. A. McCollough
D. J. Harrison
A. D. Huryn
- Cooperators/
Project
Support:* Maine Department of Inland Fisheries and Wildlife
Central Maine Power
U.S. Fish & Wildlife Service -
Partnerships for Wildlife
Maine Outdoor Heritage Fund
McIntire-Stennis
University of Maine
Department of Wildlife Ecology
- Objectives:*
- 1) Build and test a thermal model of nesting success (thermal regime is a hypothesized major limiting factor on nest survival in western Maine and a possible determinant of northern range limit). Predict northern range limit from thermal nesting success, and compare this with known distribution.
 - 2) Model habitat selection at watershed and microhabitat scales.
 - 3) Determine whether water releases from a dam upriver from the study site are reducing nesting success.
 - 4) Test effectiveness of state wetland protection regulations at protecting wood turtle habitat.
 - 5) Build a demographic model to estimate the effects of anthropogenic adult mortality on populations.

SCOPE: Wood turtle populations appear to be declining throughout their range. The wood turtle is listed in 13 of the 17 states in its range and is protected in the four Canadian provinces where it occurs. Wood turtle populations are threatened by habitat destruction and fragmentation, high populations of nest predators such as raccoons and skunks, road kills, and collection of adults for the pet trade. The wood turtle shares with most turtle species a life history strategy of low nest and juvenile survival, late maturity, and high adult survival that leaves it vulnerable to increases in adult mortality. The slow growth potential of turtle populations (population doubling times have been estimated in the thousands of years for some species) suggests that a strategy for conserving turtles must be especially proactive.

Wood turtle habitat use and population dynamics have not been well-studied, especially in New England. Preliminary work has shown that western Maine wood turtles use habitat differently than do other populations that have been studied, and that constraints on nesting success differ. Wood turtles in the study population tend to move much greater distances and to use areas such as bogs and fens where they are not found elsewhere in their range. Nesting success appears to be limited by the short, cool summers of western Maine, rather than by nest predators.

This project continues a radio-telemetry study of a population of wood turtles in western Maine initiated by Central Maine Power in 1994. Our goal is to obtain information that will be useful for conservation of wood turtles in Maine. We modeled egg development based upon nest temperatures, and tested this model with data collected from nests in the field as well in the laboratory. Habitat use was modeled at two spatial scales, based upon habitat sampling at turtle locations and random locations.

PROJECT STATUS: All requirements for a M.S. degree (Wildlife Ecology) were met in December 1999. The abstract follows:

Wood turtles (*Clemmys insculpta*) have declined throughout their range. They are listed as Special Concern, Threatened, or Endangered in most states in the U. S., and are listed in Appendix II of the convention on International Trade in Endangered Species (CITES). Little is known about the ecology and conservation status of wood turtles in northern New England. I studied conservation issues and habitat selection in a population in western Maine, and evaluated temperature as a potential limiting factor for wood turtles at the northern extent of their geographic range.

I observed that nesting success can be extremely low during short, cool summers. A degree-day model of incubation time was applied to historical weather data from across the wood turtle's range to estimate the proportion of years that eggs could successfully hatch, and predict the northern range limits of the wood turtle. The model supports the hypothesis that incubation temperature determines the northern range limits of wood turtles.

Wood turtles in western Maine move among several widely-separated activity areas throughout the summer. I modeled habitat selection at two scales. I used paired logistic regression to model selection within turtle activity areas, and logistic regression to model selection of activity areas within the watershed. Within activity areas, wood turtles selected nonforested locations close to water with low canopy cover. Within the watershed, they selected activity areas close to streams and rivers with moderate forest cover and little open water. The difference between selection at these two scales suggests that wood turtles select forest edges to balance thermoregulatory and feeding needs. The model of selection of activity areas within the watershed correctly classified 84% of activity areas and random areas. This model may be useful for identifying wood turtle habitat across the landscape as part of regional conservation efforts.

Anthropogenic threats to wood turtle populations in Maine include damming of rivers and streams, degradation of riparian habitat, road mortality, and collection as pets. About one-quarter of nests at my study site are destroyed annually by water releases from an upstream dam.

I used GIS to compare 2,019 turtle locations in 1997 and 1998 with zones protected by riparian and wetland regulations in Maine as a test of how well these regulations protect wood turtle habitat in my study site. Maine's Shoreland Zoning Ordinance and Champion International Corporation's Riparian Management Guidelines protected 80-85% of turtle locations from intensive forestry, whereas the Land Use and Regulation Commission (LURC) riparian regulations for the less-populated half of Maine protected only about 17% of turtle locations. Buffer zones designed to protect 99% of wood turtle locations would have to extend 300 m from river, streams, and large wetlands.

I built a simple demographic model to estimate the effect of the annual removal of a small number of adults from a hypothetical population of wood turtles. The model indicated that removal of a single adult annually from a stable population of 100 adult turtles would cause a 60% decline over 100 years, and that removal of two animals annually would extirpate the population in less than 80 years.

These analyses suggest that wood turtles are particularly vulnerable near their northern range limits. Efforts to protect riparian habitat, minimize flooding and other disturbances at nest sites, and to protect adults from collection as pets will be necessary to conserve wood turtles in Maine.

WINTER ECOLOGY OF HARLEQUIN DUCKS IN MAINE

<i>Investigator:</i>	G. H. Mittelhauser
<i>Advisors:</i>	W. E. Glanz, Chairperson W. B. Krohn J. R. Longcore
<i>Cooperators/ Project Support:</i>	Maine Outdoor Heritage Fund National Park Service - Acadia National Park

Maine Department of Inland Fisheries and Wildlife
 U.S. Fish and Wildlife Service -
 Petit Manan National Wildlife Refuge
 Gulf of Maine Project
 University of Maine

- Objectives:*
- 1) Compile and analyze current and historic population data for harlequin ducks in Maine to determine population size, distribution, and trends.
 - 2) Identify significant wintering areas and determine essential characteristics of wintering habitat in Maine; compare habitat use to time of year, flock size and composition, and environmental conditions.
 - 3) Determine activity budgets for harlequins at Isle au Haut relative to day length, time of day, tide cycle, environmental conditions, and habitat.

SCOPE: The number of harlequin ducks (*Histrionicus histrionicus*) in eastern North America is estimated at 1,500 individuals and counts show population declines have occurred, and may be ongoing. More than 50% of this eastern North American population is concentrated at a small number of traditional wintering areas on the coast of Maine. Little is known about the winter ecology and population of harlequin ducks in Maine at these concentration areas. This project will address harlequin duck population size, distribution, trends, and movements in Maine, assess habitat at concentration areas, and determine activity budgets.

PROJECT STATUS: Two years of field work have been completed. The thesis has been written and was defended in September 2000.

FUTURE PLANS: A Master of Science thesis is expected by December 2000.

POPULATION ECOLOGY OF BLACK TERNS IN MAINE

Investigator: F. A. Servello

*Cooperators/
 Project
 Support:* University of Maine -
 Department of Wildlife Ecology
 Maine Department of Inland Fisheries and Wildlife
 U.S. Fish and Wildlife Service, Partnerships for Wildlife Program
 Maine Outdoor Heritage Fund
 FPL Energy

- Objectives:*
- 1) Determine the annual local survival of breeding adult black terns (*Chlidonias niger*) in Maine and site fidelity to individual wetlands.
 - 2) Determine breeding success at black tern colonies and factors influencing rates of nest and chick losses.
 - 3) Determine the relative effects of demographic parameters on population rates of change for black terns using demographic models and ultimately conduct a population viability analysis of the Maine population to evaluate extinction risk.

SCOPE: The black tern was formally state-listed as an endangered species in Maine in 1997, a legal status it also has in a number of states in the northern U.S. In Maine and the northeastern U.S., black tern populations are disjunct from the core breeding range in North America and are relatively small. The Maine population has approximately 75-100 breeding pairs distributed among 6-8 colony sites. With a few exceptions, studies of black tern ecology in North America have focused on nest success, nesting habitat, and breeding behavior apparently because the low and variable reproductive success may be a contributing factor in the slow recovery of this species and the low densities

in peripheral regions such as the northeastern U.S. Information on recruitment, survival and site fidelity needed to examine population dynamics issues is insufficient. Other than annual census data, little is known about the basic population characteristics or limiting factors of black terns in Maine. This project will provide information needed to assess the vulnerability of the existing population to extinction and its potential for future population growth.

PROJECT STATUS: The fourth year of field work has been completed. We have banded a total of 145 adults terns with USFWS metal bands and color bands. Recapture/resighting rates were sufficient enough this year for initial estimation of site fidelity and movement rates. Nest success has been measured in 6-7 colonies and fledging success has been measured in 2-6 colonies each year. A population model for black terns has been completed and used to evaluate priorities for population research.

FUTURE PLANS: Field work on these objectives is planned for years 2000-2003.

THE EFFECTS OF FOOD LIMITATION AND ENVIRONMENTAL FACTORS ON BLACK TERN PRODUCTIVITY

Investigator: A. T. Gilbert

Advisors: F. A. Servello, Chairperson
J. M. Rhymer
A. J. K. Calhoun
M. A. McCollough

*Cooperators/
Project
Support:* University of Maine -
Department of Wildlife Ecology
Maine Department of Inland Fisheries and Wildlife
Maine Outdoor Heritage Fund
U.S. Fish and Wildlife Service
Northern Maine Natural Wildlife Refuge Complex

Objectives:

- 1) Determine effects of long-term weather patterns on Black Tern nest loss and insect abundance in tern colonies in Maine.
- 2) Determine relationships between Black Tern chick growth and food provisioning.
 - a) determine if Black Tern productivity is food limited in Maine.
 - b) develop a less invasive method for monitoring Black Tern chick growth and survival.
- 3) Identify wetlands suitable for Black Tern nesting in Maine.

SCOPE: Black Terns, a state-listed endangered species in Maine, breed at 7-9 inland emergent wetlands. Limited or poor quality habitat in Maine may contribute to reduced productivity and survival, ultimately leading to its rare status in the state. Reproductive success in Black Terns may be limited by adverse weather, food-limited growth of chicks, the lack of suitable breeding habitat, and predation. I am addressing the first three as part of a long-term population study of Black Terns in Maine. This information will be used to develop conservation measures to enhance productivity of Black Terns in Maine.

PROJECT STATUS: Two years of fieldwork have been completed. Fifteen nests were enclosed at two colonies from which weight and structural growth of chicks were measured daily for a period of one week. Food provisioning observations of enclosed broods were made concurrently from tower blinds. Videography was used to determine the accuracy of food habits observations. Food habits data also was collected from observation towers in three additional colonies. Daily air and water temperature and water level data were measured at the two major colonies.

Water levels were measured at two additional colonies in 1999 and all colonies in 2000. Local rainfall was measured in both years. Precipitation and water level data will be used for analysis of nest loss due to flooding at 5 colonies. Insect abundance was monitored at one colony using aerial sticky traps in 1999 and by sweep net at two colonies in 2000. Analysis of videography data are complete. Food habits and growth data are being analyzed. A GIS-based habitat assessment of the availability of tern habitat in Maine using National Wetlands Inventory maps is also complete.

FUTURE PLANS: Final data analysis will be completed in the fall of 2000. A thesis is in preparation for winter 2001.

FISHERIES RESOURCES:

FISHERIES RESOURCES OF ACADIA NATIONAL PARK

Investigators: J. B. Lê
J. A. Stone

Advisors: J. R. Moring, Chairperson
J. G. Trial
D. P. Chivers
A. D. Huryn

*Cooperators/
Project
Support:* National Park Service -
Acadia National Park

Objective: To inventory fish species and their associated habitat in lakes and brooks of Acadia National Park, especially concentrating on life history aspects of brook trout.

SCOPE: There are no comprehensive inventories of fish species found in Acadia National Park. This project attempts to describe the species, location, relative abundance, native or non-native status, habitat associations, and associated abiotic parameters. For the students theses, several life history parameters will be studied for the native brook trout. This project will include investigations by two separate investigators over two field seasons, 1998 and 1999, studying different life history characteristics.

PROJECT STATUS: Field inventories of the Park's waters have been completed. Work on the first brook trout study--instream movements--was completed in fall 1998. Brook trout spawning locations were observed in fall 1998 and field work for the second project with brook trout was completed in early 2000.

FUTURE PLANS: A final report on fish inventories is expected in December 2000, and a final technical report of previous data on fishes was completed in June 1999. The abstract of the first M.S. thesis completed under this project, done in December 1999, is as follows:

Movements of brook trout, *Salvelinus fontinalis*, were examined at Hunter's Brook, Acadia National Park, Maine, using mark-recapture. Five fin-clip combinations were used to identify fish caught in five separate marking sections. Recapture periods consisted of sampling all marking sections and randomly chosen sections by backpack electrofishing. Water temperature, species diversity, habitat, and productivity were measured to further examine factors that may influence movements. Except for habitat, parameters measured were relatively homogenous throughout the study reach. Recaptures of marked fish outside their sections of original capture were low. Although proportions of unmarked to marked fish in the marking sections were high (35-60%) in the first recapture period, summer recapture periods had lower proportions of unmarked to marked fish (<30%) in marking sections. However,

there was an increase in unmarked-fish during the last recapture period. These proportions of unmarked fish are most likely the result of immigration. Seasonality and spawning movements may explain increases in immigration percentage in the first and last recaptures, respectively. Overall, brook trout movement was observed and detected by both recaptures of marked, mobile fish and immigration of unmarked-fish into marking sections. An interesting observation was that large proportions of immigrants were 1- and 2-year-old fish. This is contrary with previous literature on the size of mobile salmonids.

The abstract of the second thesis completed in September 2000, is as follows:

Movement of brook trout (*Salvelinus fontinalis*) between lakes and streams was examined on Mount Desert Island, Maine. In the summer of 1999, brook trout were marked (n=849) using a combination of fin clips and Floy anchor tags to differentiate stream-resident brook trout from lake-resident brook trout. Two-way fish traps were placed on inlet and outlet streams during the fall, and upstream and downstream movements of brook trout were documented. Brook trout captured in the traps received temporary caudal fin clops to identify repeat migrants. Six wild brook trout and 44 stocked brook trout moved upstream from Upper Hadlock Pond into Hadlock Stream another 10 wild brook trout and 41 stocked brook trout moved downstream from Upper Hadlock Pond into another portion of Hadlock Stream, possibly continuing into Lower Hadlock Pond. Twenty-three brook trout moved upstream from Little Long Pond into Jordan Stream, and 75 wild brook trout and 42 hatchery brook trout moved upstream from Echo Lake into Lurvey Spring. Emigration from the three lakes coincided with brook trout spawning season and was dominated by mature brook trout in spawning color. Fall emigrants were likely searching for spawning habitat, which was unavailable within the lakes but abundant within the streams. Redds, emergent fry, and young-of-the-year brook trout were observed only in the streams and not in the lakes. A geographic information system was used to assess the spatial overlap among spawning habitat characteristics, redd locations, emergent fry locations, and young-of-the-year abundance.

LENGTH/WEIGHT VARIATIONS AND MERCURY LEVELS IN AMERICAN EELS IN FRESH WATER

Investigator: N. G. Leaman

Advisors: J. R. Moring, Co-advisor
T. A. Haines, Co-advisor
J. D. McCleave

*Cooperators/
Project
Support:* Maine Department of Marine Resources

Objective: To conduct research on aspects of the freshwater residence of American eels in Maine. Mercury content of eels will be measured in conjunction with other collections with life history objectives.

PROJECT STATUS: The thesis was completed in December 1999. The abstract follows:

Mercury concentration was determined in both fillet and carcass (whole body) samples of migrating (silver) American eels, *Anguilla rostrata*, from three rivers in coastal Maine, USA. Two hundred and forty-five eels were collected using fyke nets during their seaward migration in the Medomak River drainage in midcoast Maine, and the Pleasant River and East Machias River drainages in eastern Maine. After otoliths were removed for aging, samples of axial muscle (fillet) and whole body were homogenized, and digested for measurement of total mercury concentration by cold vapor atomic fluorescence spectrometry.

The mean mercury concentration in fillets from eels from all rivers was 0.437 $\mu\text{g/g}$ wet weight, which was

significantly different from the whole body concentration of $.0333\mu\text{g/g}$. Twenty-nine percent of the eels that were collected had fillet mercury concentrations that exceeded the World Health Organization mercury consumption standard of $0.5\mu\text{g/g}$. The majority of the high mercury concentrations in American eels were from the Pleasant River drainage, which had a mean of $0.642\mu\text{g/g}$ in female eels and $0.435\mu\text{g/g}$ in males. These concentrations were significantly different from those eels sampled in the remaining two drainages. All male eels measured less than 400 mm in length, while all female eels were greater than 400 mm in length. When comparing eels in the three drainages, no differences were noted in length, weight, or age among male or female eels. A significant difference was found for age of eels sampled between males ($\bar{x}=12.1$) and females ($\bar{x}=16.0$) when eels from all locations were pooled.

Stable nitrogen isotope ratios ($\delta^{15}\text{N}$) were determined in muscle tissue from 45 eels. No significant correlations were found between $\delta^{15}\text{N}$ and fillet mercury concentrations of the eels, age, or length; $\delta^{15}\text{N}$ values were significantly different among drainages, ranging from 7.86 in eels of the East Machias drainage to 10.30 in eels of the Medomak River drainage. No significant difference was noted between sexes. However, the $\delta^{15}\text{N}$ values for male eels in the Medomak River drainage were significantly higher than those in male eels from the East Machias and Pleasant River drainages, and $\delta^{15}\text{N}$ values of Medomak drainage female eels were significantly higher than for female eels in the East Machias River drainage.

COMPETITION BETWEEN SPLAKE AND LANDLOCKED SALMON

Investigator: T. A. Hoffman

Advisors: J. R. Moring, Chairperson
J. G. Trial
D. P. Chivers
L. Kling
F. W. Kircheis

Cooperators/ Maine Department of Inland Fisheries and Wildlife
Project University of Maine
Support: Baxter State Park

Objective: To determine if competition for food exists between landlocked salmon and stocked splake (brook trout x lake trout).

SCOPE: Splake--a hatchery-produced hybrid--are being used with wider frequency in Maine waters. These fishes grow rapidly and tolerate marginal water conditions. However, there is concern that such introductions may adversely affect populations of landlocked salmon--especially if splake and salmon compete for the same foods. This project examines food habits of splake and salmon in three Maine lakes in different seasons.

PROJECT STATUS: All work has been completed. The thesis was completed in January 2000. The abstract follows:

Food habits of splake (*Salvelinus namaycush* x *S. fontinalis*) were examined in three lakes in central Maine to determine potential resource competition with landlocked salmon (*Salmo salar*). An allopatric population of splake and two populations of splake sympatric with salmon were sampled to investigate shifts in diet due to competition. Both splake and salmon were sampled using day and night gill net sets, trap nets, angling, and creel surveys. Sampling occurred in 1998 and 1999. Fishes in the stomach contents were identified to species and invertebrates were identified to family. Percent index of relative importance, percent similarity, diet diversity, and diet breadth were calculated to determine competition for food resources. Fishes (85.4%) were the most important food item in the overall diet of allopatric splake and in the summer (59.2%) and fall (97.9%) diets. Common shiners were the dominant fish species in the overall diet (64.6%) and in the fall (88.3%), while threespine sticklebacks were

the most important identifiable fish species in the summer (29.0%). Aquatic invertebrates (45.7%) were the most important food item for allopatric splake in the spring. Dipterans (68.0%) were the dominant order in the spring and were represented almost exclusively by the family Chironomidae (99.3%). Fishes (63.3%) were the dominant food item in the overall diet of splake sympatric with salmon, with rainbow smelt (94.12%) the only identifiable fish species. Summer was the only season with enough samples to separate from the overall diet for sympatric splake and salmon. Fishes (78.6%) were the dominant food item for sympatric splake in the summer, again with rainbow smelt (90.2%) the only identifiable species. Fishes (77.5%) were also the dominant food item for salmon sympatric with splake, with rainbow smelt (98.6%) the only identifiable fish species. In the summer, fishes (67.3%) were the dominant food item, with rainbow smelt (95.9%) the only identifiable fish. There was high overlap in diet (>79%) for all food categories of sympatric splake and salmon. Percent similarity also was calculated for allopatric and sympatric splake. There was high overlap (92.9%) for general food categories, but not for fishes (14.5%) or invertebrate orders (51.1%). Diet diversity and diet breadth were calculated for allopatric splake (1.69, 0.31), sympatric splake (0.47, 1.24), and sympatric salmon (0.65, 1.58). This indicates that splake show a more diverse diet when salmon are not present. An analysis of variance was performed on length of salmon before and after the introduction of splake and age III and IV salmon were significantly longer after the introduction of splake.

POPULATION STUDIES OF MAINE INTERTIDAL FISHES

Investigator: J. R. Moring

*Cooperators/
Project
Support:* University of Maine

Objectives:

- 1) Identify environmental conditions associated with arrival and departure of fishes in the intertidal zone.
- 2) Identify and quantify algal and food associations of intertidal fishes.
- 3) Study movement patterns of Maine tidepool fishes.

SCOPE: Intertidal fishes are unique members of the intertidal ecosystem. Tidepools serve a nursery function, and young of economically important offshore fishes utilize tidepools as refuges and nurseries. Because of specific algal and habitat associations, these fishes can be susceptible to environmental contaminants in coastal waters, both of a direct and indirect nature.

Surveys since 1979 have identified 23 species of tidepool fishes in Maine. The movements of the rock gunnel have been examined in marking studies, and algal associations and food habits of lumpfish and Atlantic seasnails have been quantified. Three study pools on Schoodic Peninsula have been studied since 1979, and work also has involved the first description of rock gunnels as the first intermediate host of the digenean fluke, *Cryptocotyle lingua* and seasonal habitat changes of tidepool fishes and sand shrimp.

PROJECT STATUS: Experiments with movements of juvenile guppies and shorthorn sculpins and distribution of sand shrimp are ongoing.

FUTURE PLANS: Work dealing with the development of a stomach lavage technique will continue in 2001. Additional manuscripts are being prepared on community dynamics and intertidal movement patterns.

POPULATION DYNAMICS OF SEA-RUN ALEWIVES

Investigator: J. F. Stahlnecker, III

Advisors: J. R. Moring, Chairperson
J. D. McCleave

J. G. Trial

*Cooperators/
Project
Support:* Maine Department of Marine Resources
Maine Department of Inland Fisheries and Wildlife

Objective: To understand the interactions and between stocking rates and the resultant numbers of juvenile alewives in Maine ponds.

SCOPE: The Maine State Legislature has instructed the Department of Marine Resources to restore sea-run alewives to their original range in Maine. To do this requires information on stocking rates appropriate for producing adequate numbers of juvenile and adult alewives. Some data from a restricted number of ponds are available, but a wider range of stocking rates is necessary to identify the appropriate stocking rates for the future.

PROJECT STATUS: Field work has been completed, a thesis had been tentatively accepted and will be defended in Fall 2000.

FUTURE PLANS: The investigator is enrolled on a part-time status, but is conducting the additional work in cooperation with the Department of Marine Resources. A Master of Science thesis is expected by December 2000.

MOVEMENTS OF AMERICAN EELS IN FRESHWATER LAKES

Investigator: M. Gallagher

Advisors: J. R. Moring, Chairperson
J. G. Trial
D. P. Chivers
A. D. Huryn
J. D. McCleave
F. W. Kircheis
W. E. Glanz

*Cooperators/
Project
Support:* Maine Department of Marine Resources
Maine Department of Inland Fisheries and Wildlife

Objective: To document seasonal and daily movement patterns of American eels and relate these movements to habitat and environmental conditions.

SCOPE: Little is known about the commercially-important American eels in their freshwater residence, especially their habitat selection and patterns of movement. This project captures eels and tracks their movements using surgically-implanted radio transmitters. In Year 1, all field work was conducted in Hermon Pond. In Year 2, the studies were expanded to include several other ponds, along with habitat mapping of ponds.

PROJECT STATUS: Field work for Year 3 has been completed and data processing, degree requirements, and thesis writing will occur in late 2000 and early 2001.

FUTURE PLANS: Analysis of data will occur well into 2000. A Ph.D. dissertation is expected in May 2001.

RELATIONSHIPS BETWEEN STREAM GEOMORPHOLOGY

AND FISH COMMUNITY STRUCTURE

- Investigator:* E. Gaenzle
- Advisors:* J. R. Moring, Chairperson
A. D. Huryn
J. G. Trial
- Cooperators/
Project
Support:* Maine Department of Inland Fisheries and Wildlife
University of Maine
- Objective:* To supplement existing databases with field measurements to determine whether fish community structure can be predicted by measurements of stream habitat characteristics.

SCOPE: The State of Maine has stream survey data for a number of coolwater streams in the state. By incorporating other stream habitat types into a more extensive data base, this project hopes to find trends for predicting the fish community composition and numbers associated with a spectrum of habitats. The supplemental field work will be conducted in 2001.

PROJECT STATUS: Planning is just underway, with examination of existing data and planning for new surveys expected for much of winter, 2000-2001.

FUTURE PLANS: Field work to supplement existing data is expected to commence in late spring 2001 and finish by fall 2001. A M. S. thesis is expected in May 2002.

INTERTIDAL COMMUNITIES ASSOCIATED WITH ROCKWEED, *Ascophyllum nodosum*

- Investigator:* A. Gullo
- Advisors:* J. R. Moring, Chairperson
M. L. Hunter
R. L. Vadas
- Cooperators/
Project
Support:* University of Maine
National Park Service
- Objective:* To document the vertebrate and invertebrate communities associated with rockweed (*Ascophyllum nodosum*) at several locations along the coast of Maine, and demonstrate how algal height affects biodiversity.

SCOPE: Rockweed is now being harvested in great quantities along the coast of New Brunswick, and such harvesting is increasing in Maine. Studies in Canada have indicated that juvenile pollock (*Pollachius virens*) utilize patches of rockweed as refuges from predators. Rockweed also serves to concentrate prey items for inshore fishes and there is some selection of the algae for attachment by lumpfish (*Cyclopterus lumpus*) and other fishes. Recently,

environmental groups have expressed concern that extensive commercial harvesting of rockweed may harm fish and invertebrate nursery communities along the coast of Maine. This project attempts to document the specific animals associated with rockweed and their dependence on this marine algae.

PROJECT STATUS: The project is just underway, with planning expected during winter, 2000-2001.

FUTURE PLANS: Field work will commence in spring 2001 and continue until fall 2001. A M. S. thesis is expected in May 2002.

HABITAT RESOURCES:

AMPHIBIAN DISTRIBUTIONS IN AN AGRICULTURAL AND FORESTED MOSAIC: FOREST EXTENT, POND ISOLATION, AND LANDSCAPE

Investigator: A. D. Guerry

Advisors: M. L. Hunter, Chairperson
R. J. O'Connor
D. J. Harrison
A. J. K. Calhoun

*Cooperators/
Project
Support:* McIntire-Stennis
National Science Foundation
Maine Association of Wetlands Scientists

Objectives:

- 1) Document the distribution (and in some cases relative abundance) of breeding amphibians in ponds in a variety of landscapes that represent predominantly agricultural landscapes, predominantly forested landscapes, and patchy combinations of the two. Determine whether or not the context in which a pond lies affects the species assemblage that breeds there.
- 2) Determine whether or not connectivity of habitat-patches mitigates the effects of habitat loss by looking at a number of different landscapes (1 km circles centered on breeding ponds) with the same areas of natural habitat but different spatial arrangements of habitat-patches with respect to the ponds.
- 3) Locate potential thresholds at which the amount of open-land surrounding a pond prohibits particular species from using breeding pools or reduces the probability of a species occurrence.

SCOPE: One of the themes of landscape ecology is that the landscape mosaic surrounding a patch is often more important to patch function than are characteristics within the patch. This study tests this paradigm in a particular case. The landscape pattern in eastern Aroostook County provides a valuable opportunity to test theoretical models of habitat fragmentation. In this fragmented landscape, an inhospitable agricultural matrix separates many ponds from the surrounding uplands. For many amphibians, agricultural practices can limit the use of preferred breeding habitat because migration from woodland hibernacula to breeding ponds in Spring must be across a matrix with very little protection from the drying effects of wind and sunlight. Juvenile dispersal, immigration, and re-colonization can also be limited in a fragmented landscape such as eastern Aroostook County.

PROJECT STATUS: All requirements for a M.S. degree (Wildlife Ecology) were met in August 2000. The abstract follows:

Both the landscape context and the local characteristics of a habitat patch are likely to be important determinants of the community within the patch. I explored these relationships by examining patterns of amphibian

species occupancy of 116 ponds in an agricultural and forested mosaic in northeastern Maine. First, I tested for associations between occupancy by amphibians and forest extent and pond isolation; second, I developed and tested descriptive models of occupancy by each species using local and landscape characteristics.

Habitat fragmentation comprises two processes of concern loss and isolation that are not easily distinguishable. I examined forest extent and pond isolation for forest simultaneously by studying breeding ponds that were isolated from or connected to forest and were surrounded by different amounts of forested land. I surveyed each pond using visual surveys and call surveys to determine occupancy by amphibians. Because the area of forest and pond adjacency to forest were not associated ($t = -0.1247$, $n_{\text{isolated}}=64$, $n_{\text{connected}}=52$, $P=0.21$), these factors were given separate opportunities to manifest their effects. I used logistic regression to test predictions regarding associations between each species and forest area as well as to test for associations the pond isolation.

My results suggest that the composition of uplands and the connections between wetlands and upland forests may affect the distribution of amphibians in agricultural landscapes. Seven of nine species were associated with forest area. Wood frogs (*Rana sylvatica*), green frogs (*Rana clamitans*), eastern newts (*Notophthalmus viridescens*), spotted salamanders (*Ambystoma maculatum*), and blue-spotted salamanders (*Ambystoma laterale*) were more likely to occupy ponds with more forest area; Leopard frogs (*Rana pipiens*) and American toads (*Bufo americanus*) were negatively associated with forest area. Three species were associated with isolation from forest. Spotted salamanders and blue-spotted salamanders were less likely to occupy ponds that were isolated from forest. In areas with little forest, leopard frogs were more likely to occur in connected ponds, but the reverse was true for areas with extensive forest. Spring peepers and mink frogs were neither associated with forest area nor with pond isolation. My results suggest that, at least for some species, it is important to recognize both the extent and configuration of habitat.

Because forest area and pond isolation are only two factors that might influence amphibian distributions, I further examined amphibian distributions by building and testing descriptive models with a larger suite of variables describing landscape contexts and pond characteristics. I built classification tree models for each of six species (wood frog, leopard frog, American toad, mink frog, spotted salamander, and blue-spotted salamander) and tested the models on a reserved set of 25 ponds. The models explained the 14 to 53% of the variation in the data, generally discriminated occupancy well and, with one exception, were likely to discriminate occupancy better than a null model. Results from the models indicated that both local and larger-scale factors are correlates of the occurrence of amphibians, stressing the importance of examining habitat associations at multiple scales.

DEVELOPMENT AND TESTING A HABITAT MAP FOR MAINE

Investigator: J. A. Hepinstall

Advisors: S. A. Sader
W. B. Krohn

*Cooperators/
Project
Support:* USGS Biological Resources Division
Maine Cooperative Fish and Wildlife Research Unit
University of Maine -
Department of Forest Management
Maine Image Analysis Laboratory
Department of Wildlife Ecology

Objectives:

- 1) Classify satellite images and create a vegetation and land cover map of Maine at a 1:100,000 scale.
- 2) Evaluate map classification accuracy with a minimum of 80% correct for major habitat types.
- 3) Prepare final report and publications.

SCOPE: As biodiversity is decreasing and many wildlife species and their habitats are becoming threatened, we need more comprehensive information for conservation efforts. A major requirement for conservation is a reliable

statewide habitat map to provide a base for predicting distribution of wildlife species. Ground investigation is time consuming, expensive, and inefficient for large area surveys. Satellite images have advantages for statewide habitat mapping. This research uses aerial videography and satellite imagery to map habitat types for Maine.

PROJECT STATUS: The project was completed with the publication of “Development and Testing of a Vegetation and Land Cover Map of Maine”, Technical Bulletin 173 of the Maine Agriculture and Forest Experiment Station in September 1999. The summary and conclusion are as follows:

This report outlines the objectives, procedures, final output, and accuracy assessment of the vegetation and land cover map for use in a Gap Analysis of Maine (ME-GP). In addition, summary analysis of forest data based on Maine townships, counties, and ownerships are included as well as a comparison with results of the 1995 forest area statistics for Maine compiled by the U.S. Department of Agriculture’s (USDA) Forest Service (USFS) (Acronyms are listed in Appendix B).

ME-GAP, conducted between 1991 and 1998, used satellite image processing for vegetation and land cover map development initiated during the summer of 1995. We were responsible for creating a vegetation and land cover map with a minimum of 80% accuracy for major types. Our final vegetation and land cover map is most applicable at the 1:40,000 scale (or smaller) and contains a minimum area or polygon size of 0.81 ha (2 ac), while retaining the original 0.09 ha (0.22 ac) pixel size in a raster format.

Landsat-Thematic Mapper (TM) imagery for the state was used, along with ancillary geographic information system (GIS) data, such as U. S. Fish and Wildlife Service National Wetland Inventory (NWI) maps, to delineate 37 different vegetation and land cover types. Supervised, unsupervised, and hybrid approaches to image classification were used. With supervised classification, the image-processing analyst picks discrete examples of known vegetation types and used these areas to develop multivariate statistics (i.e., band mean, covariance) to classify an image into vegetation types. Unsupervised classification, conversely, used statistical routines to group reflectance patterns into clusters, which are then labeled by the analyst into vegetation types. A vegetation classification scheme was developed for this project that represents a compromise between habitat types required as input into wildlife-habitat models and classes we felt we could discern from the TM imagery and available ancillary GIS layers (e.g., transportation, wetlands, field locations).

Training samples for the supervised portions of our image classification were derived from statewide aerial videography transects flown in June and October 1994. Approximately 11 million frames of wide angle (210 ha coverage) or zoom (0.09 ha coverage) were available. From this dataset, 5,629 polygons were identified on the TM data and labeled according to cover type for use in training TM data and testing the accuracy of the final map.

Spectral confusion occurred among some vegetation types, requiring ancillary GIS data to differentiate these classes. Specific classes that were confused included plowed fields, recent clearcuts, burnt blueberry fields, and residential/urban areas; early regeneration, unburned blueberry fields, shrub/scrub wetlands, and peatlands; and different stages of regeneration vs. Partially harvested areas. Ancillary data sources included aerial videography, NWI maps, wetland polygons from the U.S. Geological Survey (USGS) Land Use/Land Cover Digital Analysis (LUDA) database, transportation network, and point locations for blueberry and hay fields. For the portions of the state where NWI maps were unavailable in digital form, wetlands were classified according to the training samples available for the aerial videography and NWI paper maps. The transportation network, derived from the USGS Digital Line Graph database, was used for delineating residential and urban areas. Point locations of abandoned, blueberry, and hay fields, collected in the field during the summer of 1994, were used to discriminate agricultural fields from early regeneration or residential areas.

Statewide classification proceeded on a TM scene-by-scene basis, thereby limiting the effects associated with radiometric scene differences from different acquisition dates. Eight full TM scenes and one partial scene were required to obtain statewide coverage. Two years (1991 and 1993) of statewide imagery were obtained with cooperation from the Maine Department of Conservation (1991 imagery) and the Multi-Resolution Land Characteristics program (1993 imagery). Imagery from 1991 was geo-referenced (rectified) into Clark 1866 Spheroid, North American 1927 (NAD 27) datum, and Universal Transverse Mercator (UTM) projection with 30-m pixel resolution. Imagery from 1993 was geo-referenced to the 1991 imagery.

Ten-band image files were created from the 1991 and 1993 imagery. A radiometrically corrected statewide mosaic of TM bands 3, 4, and 5 was available for 1991 whereas all six non-thermal TM bands were available on a scene-by-scene basis for 1993 imagery. Five themes were used from each year: TM bands 3, 4, 5, and normalized 4/5 and 4/3 ratios for 1991; principal components 1, 2, 3, and normalized 4/5 and 4/3 ratios for 1993. Principal

component analysis was not run on 1991 imagery because we did not have all six non-thermal bands available. The first three principal components for the 1993 data represented 97% of the overall variability of the six original bands.

The two ratios chosen for each date have been used in vegetation and land cover change detection studies and were useful in discriminating seasonal and annual variation in our datasets. A mixture of supervised (using 25% of the interpreted videography polygons as training sites) and unsupervised classifications were used for each scene.

Once the statewide classification was complete and all TM scenes were stitched together, several majority filters were used to screen out artifacts of the cloud- and water-masking, classification, and edge-matching processes. The program MegaMerge 52 was used to intelligently filter contiguous areas (polygons) in our raster dataset up to a minimum size of 0.81 ha while still retaining the 30-m pixel size. Modifications to the preliminary map classification were made at the scene level to produce the final map.

The final vegetation and land cover map was tested with the remaining 40% of the videography polygons. Eighty percent accuracy was required for all major vegetation type. Results from the final accuracy assessment indicate an overall accuracy of the map for five superclasses (agricultural land, forestland, wetlands, developed lands, and other) was 88%. The commission and omission accuracies of forest vs. nonforest classes were well over 90%. Within regrouped forest types (regeneration, hardwood, softwood, and mixed), the agreement with interpreted videography ranged from 60% to 80%, except for mixed forest which had only 45% agreement. The low agreement of mixed forest is expected given the ambiguous nature of defining a cutoff between deciduous, mixed, or coniferous forest.

Potential users of this map must realize the map was designed to be used as data input into statewide wildlife-habitat models to predict the occurrences of terrestrial vertebrates that regularly breed in Maine. As such, it may be inappropriate for other, smaller areal extent applications. For example, a landowner expecting to predict the composition of his/her 10-acre woodlot will find that stand boundaries and forest species compositions may not match well with our map.

Results of our statewide mapping effort are summarized by environment variables (biophysical region, elevation, slope-aspect), political boundaries (counties, towns), and ownerships (nonindustrial and industrial owners). We also provide a comparison of our results with the forest area estimates from the 1995 USFS statewide inventory and the results of a Maine Forest Service study. Suggestions for improving future mapping of Maine's vegetation and land cover with remotely sensed data are provided.

For more information on ME-GAP and current data see the ME-GAP web site:

<http://wlm13.umenfa.maine.edu/progs/unit/gap>

HABITAT ASSESSMENT SUPPORT TO THE MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

Investigators: J. A. Hepinstall
W. B. Krohn

*Cooperators/
Project
Support:* Maine Department of Inland Fisheries and Wildlife
Maine Cooperative Fish and Wildlife Research Unit
University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) Develop digital data resources for use in GIS analyses.
- 2) Support MDIFW personnel in preparing habitat portion of species assessment.
- 3) Develop a Southern Maine Habitat Analysis system to aid towns with land use and conservation planning.

SCOPE: The purpose of this study is to determine the feasibility of doing habitat assessment for selected species of high priority to the MDIFW. The ultimate objective is to incorporate statewide habitat data in MDIFW's planning and species assessment processes, thus bringing the levels of habitat analyses up to the levels of detail for the population analyses.

PROJECT STATUS: Project contract completed. Digital data developed included 1) statewide mosaic of 1:24,000 scale National Wetland Inventory (NWI) data, integration of rivers, streams, lakes, and ponds into a complete database, and American Woodcock Singing-Ground Survey routes were digitized and tied to the survey data. In addition, several databases were developed to support the Southern Maine Landscape Analysis planning project discussed below.

Modeling of American Woodcock habitat was started using the digital data discussed above and the 1993 vegetation and land cover map of Maine developed by the Maine Gap Analysis Project. Several modeling strategies were attempted including logistic regression, classification and regression trees, and rule-based models. Testing of model predictions was begun. Further work on this project is expected through a new contract agreement with MDIFW.

A method to identify habitats, that if conserved, could be expected to maintain terrestrial vertebrates (= wildlife) currently breeding in southern Maine into the future was developed with the Maine Department of Inland Fisheries and Wildlife (MDIFW). This method is based on digital maps and thus can be analyzed with a Geographic Information System (GIS). Southern Maine was selected for study because this region contains the greatest diversity of plants and animals in the state, has relatively few conservation lands, is experiencing sprawl into rural areas, and is projected to lose 569 mi² (1,473 km²) of agricultural and forest lands by 2050. The backbone of the method is the presumed conservation of habitats immediately adjacent to all waterways and water-bodies, termed Shoreland Zones.

Added to this backbone are other habitats recognized by the Maine Legislature as worthy of conservation; these we termed Important Habitats. Although some upland vegetation occurs in the Shoreland Zones and Important Habitats, these areas are comprised mostly of lowland vegetation. Currently, 270 wildlife species (amphibians = 17, reptiles = 16, birds = 183, mammals = 54) are estimated to inhabit southern Maine, with 80% to 95% (median = 85%) having adequate habitat (defined as the types of habitats needed to support >10 individuals of that species in the town) in Shoreland Zones and Important Habitats. Wildlife not captured by Shoreland Zones and Important Habitats are those medium-to-large-bodied birds and mammals requiring large areas of uplands. To identify habitats for these species, blocks of agricultural and forest lands not intersected by roads, pipelines, powerlines, or railroads were mapped in the GIS. The conservation value of these relatively intact upland blocks, if maintained in current cover conditions, should be assessed in terms of size (i.e., the bigger the better) and location (i.e., the more connected to other habitats the better). Advantages of the method include that it deals with issues and habitats familiar to towns, and is computerized and hence cost efficient and practical to apply across southern Maine. Although the approach does have limitations (e.g., assumes complete data, town-scale too small for some species), these are addressed within this analysis method. The habitats identified by this method, if conserved, can reasonably be expected to maintain a town's terrestrial wildlife well into the future.

FUTURE PLANS: Publish the results for the analysis of terrestrial habitats in southern Maine and initiate work on wetland habitats.

A LONG-TERM FOREST ECOSYSTEM STUDY

Investigators: M. L. Hunter, Jr.
A. J. Kimball
A. S. White
J. W. Witham
S. E. Gerken
H. Tedford

*Cooperators/
Project
Support:* Holt Woodlands Research Foundation
McIntire-Stennis
Maine Outdoor Heritage Funds
Baldwin Foundation

Objectives: 1) Describe the structure of the plant and animal communities in an oak-pine forest

- ecosystem.
- 2) Investigate the effect of woodlot management on community structure.
 - 3) Document phenological, interannual, and long-term changes in community structure.

SCOPE: Thousands of people own woodlots, and they control a resource that is not currently being adequately managed despite a growing demand for forest products. To many landowners, perhaps most, economic return from timber extraction is secondary to considerations such as recreation, aesthetics, and wildlife. In the absence of management advice, these people often choose not to manage their land at all. Thus, there is a great need for information on how to manage small woodlots, particularly in ways that maintain or enhance wildlife and similar values.

This study is being conducted for 20 years on a 120 ha, red oak-white pine woodlot in Arrowsic, Maine, called the Holt Forest. We have selected a 40 ha tract and divided it into forty 1-ha blocks with 20 ha serving as a control area and 20 ha as an experimental area.

Our primary objective is to describe the structure of the plant and animal community. We are undertaking (1) a 100% inventory of trees (>10 cm DBH) and intensive inventories of tree regeneration, (all trees are being individually numbered and, on 12 tracts, mapped); (2) a complete description of the vascular plant vegetation using the relevé technique; (3) an inventory of all breeding bird territories; (4) transect surveys of nonbreeding birds; (5) small mammal trapping; (6) salamander quadrat counts; (7) observations of reproductive efforts (flowering and fruiting) for 13 herb and shrub species; (8) estimates of seed and fruit production; (9) general surveys of canopy insect abundance; and (10) meteorological observations. These data, largely population estimates, are integrated by area units (usually 0.25 ha blocks) and analyzed to portray the forests' community structure. After five years of gathering baseline data, in 1987 we began managing the experimental area with three objectives: (1) increase wood production; (2) increase wildlife diversity and abundance; and (3) maintain the forest's aesthetic value. By continuing to monitor populations and processes, we can attain the second objective. Over the course of 20 years, we will begin to understand how the community changes seasonally and from year to year; this is the essence of the third objective.

PROJECT STATUS: In 2000, tasks 3, 4, 5, 6, 8, 9, and 10, as outlined above, were completed.

FUTURE PLANS: The 2001 field season will replicate the 2000 field season with additional work on plants and trees.

WILDLIFE COMMUNITIES OF VERNAL POOLS IN SOUTHERN MAINE

Investigator: A. M. Perillo

Advisors: M. L. Hunter, Jr.
M. A. McCollough
K. E. Gibbs
S. C. Gawler

*Cooperators/
Project
Support:* Maine Department of Inland Fisheries and Wildlife
University of Maine -
Department of Wildlife Ecology
U.S. Fish and Wildlife Service
U.S. Forest Service
U.S. Environmental Protection Agency

Objectives: 1) Describe the biotic community of vernal pools in southern Maine, including reptile, amphibian, macroinvertebrate, and plant species;

- 2) Characterize the physical, chemical, and biological parameters that contribute to the value of these pools for wildlife.
- 3) Develop guidelines for predicting wildlife values of vernal pools in southern Maine.

SCOPE: Wetlands are well recognized as highly productive communities, and in Maine are used by a disproportionate number of state-listed rare, threatened and endangered species. Currently, Maine laws generally protect only wetlands greater than 10 acres. Small wetlands in southern Maine are in immediate peril, due primarily to residential development causing habitat degradation and loss. Recent studies have demonstrated that several populations of the state-threatened spotted and Blanding's turtles are centered in wetland complexes in southern Maine dominated by vernal pools. Vernal pools are also extremely important breeding habitat for many amphibian species, serving as centers for mating, egg deposit, embryonic development, larval development, and metamorphosis. Many amphibian species return to their natal pools to breed. Therefore, local populations of state-threatened turtles and many amphibian species could be severely limited or extirpated by loss of vernal pools. The information collected in this study will provide a basis for consideration of additional protection initiatives for small wetlands in Maine.

PROJECT STATUS: Forty-five vernal pools were selected for study in York County, Maine. Field work was completed during April-September 1994 and 1995. Data collection included counting amphibian egg masses, trapping larval amphibians and aquatic invertebrates, surveying to determine the presence and abundance of reptiles, amphibians and other vertebrate species using the pools, and conducting aural surveys of breeding frogs and toads using the pools. Other data collected included water temperature, depth, pH, and conductivity, pool shrinkage and hydroperiod, pool flora, vegetation type, structure and percent cover for all vegetation growing within or overhanging pools, and average tree height and forest type of area surrounding pools. Invertebrate samples were sorted, identified, and counted during 1995 and 1996. Additional fieldwork was conducted during the winter of 1997 to gather data on solar input for all pools. Analysis was conducted in Spring 1997, and a preliminary report of research results was prepared.

FUTURE PLANS: A final thesis is in preparation.

BARK INVERTEBRATES OF WHITE PINE AND RED OAK SNAGS IN A SOUTHERN MAINE FOREST

Investigator: D. L. Nelson

Advisors: M. L. Hunter, Jr.
R. J. O'Connor
A. S. White
S. A. Woods
C. S. Stubbs

*Cooperators/
Project
Support:* Holt Woodlands Research Foundation
University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) Document the invertebrates on and within the bark of standing dead pines and oaks in the Holt Research Forest.
- 2) Relate variability in abundance and taxa composition of these invertebrates to characteristics of the snags and their local environment.
- 3) Document the characteristics and availability of snags within the Holt Research Forest from 1984 to 1996.

SCOPE: Dead wood is an important component of many forest ecosystems. Trees in various stages of decay contribute structural diversity to forests, serve as long-term nutrient sources and sinks, reduce erosion, contribute to soil development and enrichment, influence seedling establishment, provide habitat for mammals, birds, amphibians, reptiles, invertebrates, plants, and fungi, and retain moisture through times of drought. Of all organisms that use decaying wood, invertebrates compose possibly the largest and most diverse group. Invertebrates also play essential roles in the process of wood decomposition. Even so, comparatively little is known about the ecology of most wood-loving invertebrates.

Current forest management practices often discriminate against dead trees, which are reduced through thinnings and short rotations, eliminated as both fire and safety hazards, and destroyed to prevent the spread of timber pests and diseases. These practices may alter the size, species composition, and recruitment rate of dead trees, affect patterns of decay and nutrient cycling, and cause ecosystem simplification. The implications of such practices on forest ecosystems are just beginning to be investigated.

This study is designed to address issues relating to invertebrate and dead tree conservation. I wish to quantitatively explore the links between snag condition and the community attributes of bark invertebrates. I also wish to explore the dynamics of snag production and decay. This knowledge could be important for the wise management of forest resources.

PROJECT STATUS: Invertebrate samples were collected from logs, snags, and live oaks and pines throughout the summer of 1997 and identified to varying degrees, depending upon the availability of published keys and help from expert taxonomists.

FUTURE PLANS: A final thesis is in preparation. In addition, the timber inventories conducted in 1984, 1988, and 1996 will be used to examine the numbers and kinds of snags available in the forest, and the rate of snag production and fall.

REPRESENTATIONAL ANALYSES OF CONSERVATION AREAS IN MAINE

- Investigator:* S. L. Orndorff
- Advisors:* W. B. Krohn, Chairperson
M. L. Hunter
M. K. Beard-Tisdale
- Cooperators/
Project
Support* USGS Biological Resources Division
Maine Cooperative Fish and Wildlife Research Unit
University of Maine -
Department of Wildlife Ecology
Maine Outdoor Heritage Fund
- Objectives:*
- 1) Measure how similar the abiotic and biotic variables are on conservation areas versus non-conservation areas of Maine.
 - 2) Aggregate the variables and spatially analyze the highly under-represented areas from the represented areas on the major biophysical regions of Maine.
 - 3) Conduct a representational analysis on the most under-represented biophysical region of the state with similar abiotic and biotic variables.
 - 4) Assess the degree to which terrestrial vertebrates and major environment variables are represented on state and Federal wildlife management lands in Maine.

SCOPE: While the State of Maine continues to purchase conservation areas, no scientific analysis has been done to

determine the role of existing conservation areas in conserving the state's natural heritage. A set of conservation areas that is as representative as possible of Maine's natural diversity has the greatest chance of conserving the biodiversity, and uncoordinated and unplanned decisions may seriously compromise progress toward that goal. Thus, the purpose of this study is to assess how well the conservation areas in Maine are representing the natural diversity of the state.

PROJECT STATUS: The conservation areas in Maine are incorporated into a digital database (scale = 1:100,000), which will be analyzed to determine whether or not the current conservation areas are representative of Maine's natural variability. This analysis will be separated into three chapters. In the first chapter, twelve variables (10 abiotic and 2 biotic) will be analyzed on conservation areas versus non-conservation areas using a Geographic Information System (GIS) at a 1.86 x 1.86 km resolution. Maine was divided into biophysical regions using GIS and cluster analyses and for this analysis were modified into five roughly equal-sized regions. The representativeness of the variables will be compared for the five regions in the state. In the second chapter, a similar analysis will be conducted on the most under-represented region at a 94.6 x 94.6-m resolution. Similar variables will be analyzed (5 abiotic and 2 biotic) along with a threat and opportunity variable, road density. The areas identified as under-represented by this analysis will represent important areas for conservation acquisition, assuming the State of Maine's goal is to have a sample of conservation areas that fully represents the natural diversity in the state. The third chapter will assess the contribution of State Wildlife Management Areas (WMAs) and Federal National Wildlife Refuges (NWRs) to conservation in Maine. In addition to determining the extent to which Maine's terrestrial vertebrates are represented on these lands, representative analyses of major environmental variables such as elevation, slope, mean temperature, and snowfall will also be done.

FUTURE PLANS: All analyses are completed and the initial draft of the thesis will be submitted to the committee for review.

INVESTIGATIONS OF THE ACCURACY TESTS OF PREDICTED VERTEBRATE OCCURRENCES FROM GAP ANALYSIS

Investigator: S. M. Schaefer

Advisors: W. B. Krohn, Chairperson
D. J. Harrison
S. A. Sader
R. B. Boone (*ad hoc* member)

*Cooperators/
Project
Support:* Gap Analysis Program
U. S. Geological Survey Biological Resources Division
Maine Cooperative Fish and Wildlife Research Unit
Department of Wildlife Ecology, University of Maine

Objectives:

- 1) Determine if there is a relationship between the percent of errors reported and the type of test data available (long-term versus short-term field inventory), the size of test site, and definition of what constitutes a breeding species.
- 2) Determine if the commission errors reported for avian's from ME-GAP relate to *a priori* measures of ease of inventory termed Likelihood Of Occurrence Ranks.
- 3) Partition out the potential sources of error (i.e., range limits, habitat map, habitat model) in the predicted avian occurrences using the Breeding Bird Survey as the standard of comparison.

SCOPE: Predicted vertebrate occurrences from gap analysis, a national program of the USGS Biological Resources

Division, are currently tested by comparison with existing species lists for a selected conservation area. The reporting of omission error (percentage of species that occur on the area but are not predicted) and commission error (percentage of species not reported on an area that are predicted) for a state project gives an indication of how well the models and data layers used correctly predicted species occurrences. Limitations associated with the current method of accuracy assessment range from variability in the size of test sites used, to the difficulty that comes with trying to qualitatively interpret the omission and commission error. The purpose of my research is to explore these limitations and questions so that future tests of predicted vertebrate occurrences can be strengthened.

PROJECT STATUS: Investigation into all objectives has been completed. Draft reports of the first and last objective have been reviewed. A report on the second objective is being drafted. The report for the third objective is in press.

FUTURE PLANS: Finish the report of the second objective and have committee review entire product. Thesis completion is scheduled for May 2001.

OCCURRENCE AND HABITAT RELATIONS OF CANADA LYNX (*Lynx canadensis*) AT SELECTED TEMPORAL AND SPATIAL SCALES IN EASTERN NORTH AMERICA

Investigator: C. L. Hoving

Advisors: W. B. Krohn, Co-Chairperson
D. J. Harrison, Co-Chairperson
M. K. Beard
W. J. Jakubas

*Cooperators/
Project
Support:* University of Maine –
Department of Wildlife Ecology
Maine Cooperative Fish and Wildlife Research Unit
Maine Department of Inland Fisheries and Wildlife
National Council of the Paper Industry for Air and Stream
Improvement, Inc.
U.S. Fish and Wildlife Service

Objectives:

- 1) Document the current and historical distribution of lynx in Maine, 1833-1999, and discuss reasons for historic shifts in abundance and distribution.
- 2) Develop and test a predictive habitat model for lynx for the northeastern U. S. and eastern Canada
- 3) Develop a model of snowshoe hare (*Lepus americanus*) habitat relations at the scale of the state of Maine.
- 4) Develop and test a predictive habitat model for lynx at the scale of the state of Maine.

SCOPE: The U.S. Fish and Wildlife Service published their intent to list the Canada lynx under the federal Endangered Species Act in March 2000. The state of Maine is one of the few states in which lynx occur; however, knowledge of the ecology of lynx in eastern North America is limited. The ecological processes that determine lynx habitat occur at many temporal and spatial scales. Therefore a multi-scale approach to lynx habitat modeling is necessary.

PROJECT STATUS: The analysis of historic and current distribution of lynx in Maine is finished, and a draft of that chapter of the thesis is being reviewed by my advisors. The analysis of snowshoe hare habitat is complete, and part of that chapter has been written. A preliminary regional model has been built and part of that chapter has been written. Statistical analysis for the statewide lynx model is in the exploratory stage of model building.

FUTURE PLANS: I plan to finish the analysis for the regional model, and apply a similar methodology to the statewide model by November 2000. Project completion is anticipated in February 2001.

EXPLORING GRASSROOTS EFFORTS TO MONITOR WILDLIFE

Investigator: R. Purtell

Advisors: M. L. Hunter, Jr.
R. J. O'Connor
D. M. Mageean

*Cooperators/
Project
Support:* Eastern Maine Conservation Initiative
Penobscot County Conservation Association
University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) Determine the mission, monitoring proficiency, expert input, and infrastructure of grassroots wildlife monitoring groups in Maine.
- 2) Describe dominant trends, variables, and implications of these four facets of grassroots monitoring efforts.
- 3) Synthesize a description of the current and potential value that grassroots monitoring programs have to wildlife conservation.
- 4) Present a profile of grassroots wildlife-monitoring groups, and an inventory of such groups in Maine.

SCOPE: Conservation biologists extol the virtues of community-based conservation strategies that incorporate local people, leaders, and institutions. Research into the roles that local people play in conservation has focused on projects initiated by government agencies, environmental organizations, and industry. Little attention has been given to truly grassroots approaches: those that begin with citizens in a community, evolve in response to local interests, and carry potential for effective and lasting biological conservation. This project examines grassroots groups that monitor wildlife to explore current and potential values such groups might have for wildlife conservation.

Using written questionnaires and in-depth interviews of approximately 25 coordinators, I will explore the 1) mission, 2) monitoring proficiency, 3) expert input, and 4) infrastructure of grassroots groups. Following analysis, I will describe dominant trends, variables, and implications of these four facets of grassroots monitoring efforts. Given the relative paucity of research into citizen-based conservation activities, my research should help address the current gap in knowledge, create an awareness of grassroots resources available to biologists, generate hypotheses for subsequent investigation, and hopefully inspire others to pursue research on the human dimension of wildlife conservation.

PROJECT STATUS: Questionnaires and interviews were completed in January 2000. Taped interviews were transcribed into text files. Analysis and synthesis of responses has begun.

FUTURE PLANS: Analysis of questionnaires, interview texts, and summaries will continue through the month of December with project completion scheduled for the end of March 2001.

DOCUMENTATION OF SAVANNAH RIVER MARSH CONVERSION AND MODIFICATION OF SPATIAL VEGETATION SUCCESSION MODEL

Investigator: T. Henrichon

Advisors: C. S. Loftin, Chairperson

M. K. Beard-Tisdale
S. A. Sader
M. L. Hunter

*Cooperators/
Project Support:*

US Geological Survey, Biological Resources Division

Objectives:

- 1) Document current vegetation community distributions in the marshes of the Savannah National Wildlife Refuge.
- 2) Compare recent vegetation distributions to previously mapped distributions (1990 and 1997) to document landscape-level marsh conversion.
- 3) Assess the accuracy of marsh conversion predictions made in 1990 by Pearlstine et al., and modify their vegetation succession model to reflect changes in marsh composition that have actually occurred.

SCOPE: The Savannah National Wildlife Refuge (NWR) is responsible for management and protection of the freshwater and brackish marshes occurring within its borders, which are also adjacent to the Savannah River harbor. During the past several decades several changes to the flows and bathymetry of the Savannah River and harbor have occurred that may be altering the vegetation communities in the marshes of the adjacent NWR. A recent proposal to deepen the harbor basin resulted in a Draft Environmental Impact Statement (EIS); conclusions of the Draft EIS suggesting no significant impact to the vegetation distributions in response to the proposed actions have been questioned. This project will determine the type and extent of change in vegetation community distributions that have occurred during the past decade, examine the performance of a marsh vegetation succession model that predicts marsh change anticipated during this period, and modify the succession model where predictions of change are in error.

PROJECT STATUS: The SPOT satellite was programmed and imagery was received for late spring 2000; imagery is also on order for early fall 2000 and late spring 2001. Ground-truthing data were gathered during June 2000 and an additional collection trip is scheduled for October 2000. Aerial videography will also be flown during October 2000; videography will be used in the image classification and ground-truthing. Searches for 1993-1994 Landsat imagery have also been conducted, and an order will be placed during October 2000. Preliminary analyses of vegetation and salinity transect data (collected in cooperation with the Florida Cooperative Fish and Wildlife Research Unit) are underway. These data will be used in refinement of the vegetation succession model.

FUTURE PLANS: Classification of 1993-1994 and 2000 imagery will begin in January 2001 and will be followed by the change assessment and initial model analyses during summer 2001.

LITERATURE SYNTHESIS OF EFFECTS OF FOREST MANAGEMENT PRACTICES ON RIPARIAN AND IN-STREAM ANIMAL BIOTA OF NEW ENGLAND

Investigators:

C. S. Loftin
M. S. Bank
J. M. Hagan
A. Whitman

*Cooperators/
Project Support:*

Cooperative Forestry Research Unit, University of Maine
US Geological Survey, Biological Resources Division
Department of Wildlife Ecology, University of Maine
Manomet Center for Conservation Sciences

Objectives:

- 1) Survey published literature (1975-2000) on effects of forest management practices on riparian and in-stream animal biota of New England.
- 2) Develop digital database of retrieved citations.

3) Summarize published literature and provide recommendations for future directions of research examining riparian forest management effects on riparian biota in New England.

SCOPE: Regional research has addressed effects of forest management on in-stream water quality in northeastern North America; however, few of these studies have concurrently monitored potential effects on the in-stream and riparian biota. Although studies in northwestern North America have examined effects of forest practices on aquatic biota, and others have noted the diversity and abundance of riparian biota and effectiveness of buffer guidelines in riparian habitat protection, these results have not been summarized in a comprehensive literature review which could aid in identifying in-stream and riparian communities and species potentially affected by forest management in New England. This makes design and application of harvest management alternatives in the northeast unlikely, if potential forest harvest effects on riparian and in-stream biota can not be anticipated. This database and literature synthesis will summarize what is known about forest harvest practice effects on in-stream and riparian biota in northeastern North America and complement the synthesis by Kahl (1996) that reviews effects of forest management practices on water quality in Maine. Potential effects of water quality degradation on in-stream and riparian biota also will be addressed. The product of this objective will be a summary and digital citation database.

PROJECT STATUS: To determine the extent of published research conducted in northeastern North America that examines the responses of wildlife (birds, mammals, amphibians, invertebrates, fish, reptiles) to riparian forest harvest, we searched 18 online databases with approximately 20 combinations of the following search words: riparian, forest, wildlife, invertebrates, stream, birds, amphibians, mammals, reptiles, biodiversity, buffer, management, insect, policy, exotic, hyporheos, groundwater, watershed, aquatic. He searches included literature published during 1967-June 2000, although not all databases indexed publications from the entire interval. Reference lists published in approximately 20 recent riparian ecology books also were compiled. Several thousand citations were reviewed, and databases were developed in EndNote citation management software with approximately 1500 citations from northeastern North America (~500) and published literature from outside this region (~1000) that were considered important papers in riparian ecology research. Published studies of effects of riparian forest manipulations on riparian biota in northeastern North America represent, <2% of the retrieved citations. Currently the databases are being edited and collated into a northeastern riparian ecology research database and a second general riparian ecology research database.

In addition to reviewing the available citations, we have used software developed by the University of Maine Forest Management Research Cooperative to tally wildlife use of New England riparian forests compiled by the USDA Forest Service (i.e., DeGraff and Rudis). Our summary of New England wildlife species utilization of riparian forests was prompted by our review of the literature: with the limited research of riparian harvest effects on New England wildlife (less than 35 papers published in the primary literature during 1967-2000), predictions of wildlife response to riparian habitat manipulation must be made based on descriptions of wildlife use of riparian areas rather than from results of studies applying controlled, riparian forest manipulations.

FUTURE PLANS: We are currently editing the EndNote databases and summarizing relevant information from the New England wildlife database. The databases and summary will be completed by 31 December 2000.

RIPARIAN BUFFER WIDTHS AND AMPHIBIAN COMMUNITIES IN WESTERN MAINE: EXPERIMENTAL AND RETROSPECTIVE APPROACHES

Investigator: D. W. Perkins

Advisors: M. L. Hunter, Chairperson
P. G. deMaynadier
W. B. Haltemen
J. M. Hagan
C. S. Loftin
R. J. Seymour

Cooperators/ University of Maine

Project Support: NcIntire-Stennis
 Manomet Center for Conservation Science
 Department of Wildlife Ecology, University of Maine
 Cooperative Forestry Research Unit
 Plum Creek

Objectives:

- 1) Determine if amphibian densities and species richness in and adjacent to headwater streams change 1-2 years after harvesting.
- 2) Determine if changes in amphibian densities and species richness vary with buffer strip width.
- 3) Determine if there is an effect on amphibian densities and species richness in these headwater stream areas 5-10 years post-harvest.

SCOPE: Forests are the dominant ecosystem in the northeastern United States, and therefore harbor much of the region's biodiversity. However, timber production is economically important in this region. Due to biodiversity and economic reasons, ecologists and foresters seek timber management practices that do not degrade ecosystems and maintain biodiversity while still maintaining profit margins. Riparian areas provide habitat for a broad array of species, are critical to maintaining stream water quality, and have been identified by the forest industry in Maine as a key area of concern. To protect these riparian areas many forestry companies leave buffer strips. It is unclear whether current regulations are adequate for water quality and biodiversity. We will use amphibians to study the effects of different buffer widths on riparian biota along first order streams in western Maine using experimental and retrospective approaches.

PROJECT STATUS: This study is being conducted in the mountainous west central region of Maine (latitude 45 25'00", longitude 70 35'00"). Treatments in the experimental approach will consist of 0 m (0'), 11 m (35'), 23 m (75') buffers with clearcuts adjacent to the buffer, and a 200 m partially harvested unit. For the experimental approach, there will be one year of pre-treatment data (2001) and two years of post-treatment data (2002-03). For the retrospective approach eight, streams will be selected that have been harvested in the last 4-10 years. Four streams will have a 23 m buffer with clearcut adjacent to the buffer strip. Four streams will have a 200 m partially harvested unit. For both approaches, pitfall traps and drift fences are being used to capture terrestrial species. We are conducting in-stream linear transect surveys turning over suitable rocks for stream salamanders. During the 2000 field season, we located streams for the experimental approach, and collected data on 3 streams for the retrospective approach. During 16,272 pitfall trapnights, we captured 381 amphibians of 5 species. During aquatic surveys, we captured 96 two-lined salamanders (*Eurycea bislineata*) and 4 redback salamanders (*Plethodon cinereus*).

FUTURE PLANS: Field work will continue through 2003. This study will be done in conjunction with a study on water quality and aquatic invertebrates by Manomet Center for Conservation Science. Data from both studies will be combined to give powerful comprehensive conclusions. Together the implications of these studies could affect forest management decisions for riparian areas across northeastern North America. These studies will aid in maintaining the enhancing the health of managed forest ecosystems by determining whether existing regulations are sufficient to maintain the biotic integrity of small streams in managed forests.

WILDLIFE RESOURCES - MIGRATORY BIRDS:

PHYLOGEOGRAPHY AND MATING SYSTEM OF AMERICAN WOODCOCK (*Scolopax minor*)

- Investigator:* H. L. Ziel
- Advisors:* J. M. Rhymer, Chairperson
D. G. McAuley
C. R. Maher
- Cooperators/
Project
Support:* U.S. Geological Survey -
Patuxent Wildlife Research Center
University of Maine -
Department of Wildlife Ecology
- Objectives:*
- 1) Study phylogeography of American woodcock using DNA sequencing.
 - 2) Study mating system of American woodcock using DNA fingerprinting and behavior observations.

SCOPE: The continental population of American woodcock (*Scolopax minor*) has declined over the last 30 years. As a result, there has been renewed interest in studying aspects of woodcock biology. Recent advances in genetic techniques have made new methods available for studies in ecology and population biology. Molecular techniques will be used to examine two aspects of woodcock biology. Banding data used to trace migration routes of birds from different regions have determined that there is a split between birds from the eastern and western portions of the species' range. I will study phylogeographic patterns of woodcock using mitochondrial DNA (mtDNA) to determine if genetic variation exists among populations. The mating system of woodcock is complex and unusual, and controversy still exists over what type of mating system they have. I will use DNA fingerprinting techniques to study paternity and the mating system of woodcock.

PROJECT STATUS: All requirements for the Masters degree (in Wildlife Ecology) were completed in December 1999. The abstract follows:

Phylogeography is the study of the geographic distribution of genetic lineages. Phylogeographic studies of several species of birds, including shorebirds, have found population structure in some species but not in others. The American Woodcock (*Scolopax minor*) is an unusual shorebird that inhabits early successional forests and fields rather than the shore. Woodcock are distributed throughout the eastern United States and Canada. Woodcock use two relatively distinct migration routes between breeding and wintering areas.

I used molecular genetic analysis of mitochondrial DNA (mtDNA) sequences to study the phylogeographic patterns of population structure and gene flow throughout the range of American Woodcock. I obtained wing samples from states and provinces throughout the primary woodcock breeding range. I sequenced two regions of the MtDNA, the variable 5' domain of the control region and the ND6 gene. I used the polymerase chain reaction (PCR) to amplify both regions, and direct sequencing was done on an ABI stretch Automatic Sequencer. I used neighbor-joining analysis and maximum likelihood analysis to examine relationships among haplotypes based on sequences. I used Analysis of Molecular Variance (AMOVA) to analyze the hierarchical population structuring of genetic variation.

American woodcock do not exhibit phylogeographic population structure. Analysis of mtDNA sequences revealed high amounts of variation that is not structured among populations; neither shared nor unique haplotypes were restricted to any geographic region. Hierarchical analysis of molecular variation revealed that only 1.15% of the variation was due to differences between flyways, essentially none (-0.04%) was due to variation among states and provinces, and the majority (99.25%) was due to variation among individuals within populations.

Mating systems are often distinguished by the spatial and temporal distribution of resources and the degree to which mates can be monopolized. The amount of parental care that each sex provides also has a strong effect on mating systems. Based on behavioral observations, the mating system of American Woodcock has been variously described as monogamous, a dispersed lek, or resource defense polygyny. Male woodcock perform elaborate mating displays that attract females to their display sites where copulations occur.

I used two microsatellite markers, developed for Ruffs (*Philomachus pugnax*), to assess paternity in American Woodcock. Microsatellite loci were amplified with PCR and sequenced on an ABI 377 automatic sequencer. In three years, I collected blood samples from 21 females and broods (68 chicks) and 90 males. I found

no evidence of multiple paternity within broods; paternity in all broods could be explained by one father. I identified possible fathers for ten broods. Three broods were found at the singing site of the putative father; five broods were found next to a neighboring male to the possible father; and two broods were found far from the singing site of the possible father. Genetic techniques used to study paternity in woodcock suggested that the mating system is similar to a promiscuous, exploded lek.

SITE FIDELITY OF SONGBIRDS IN SELECTIVELY HARVESTED AND UNHARVESTED MIXED WOODS

Investigator: M. J. Hartley

Advisors: M. L. Hunter
R. J. O' Connor
A. S. White
W. B. Halteman
W. E. Glanz

*Cooperators/
Project
Support:* University of Maine -
Forest Ecosystem Research Program
Department of Wildlife Ecology
Maine Department of Inland Fisheries and Wildlife
USDA Forest Service
Cooper Ornithological Society
American Wildlife Research Foundation

Objectives:

- 1) Describe changes in breeding bird communities on sites that are experimentally harvested (with selection silviculture), as compared to unharvested stands.
- 2) Determine if selective timber harvesting affects site fidelity of Ovenbirds and Hermit Thrushes, as estimated by: (a) annual return rates, and (b) distance between territories of successive years.

SCOPE: Forests are dynamic ecosystems that may only be understood through long-term research projects that focus on many different aspects of structure, function, and biota within and between stands. The Forest Ecosystem Research Program (FERP) was formed to address such long-term research issues. The FERP has established nine long-term research sites (10 ha each) at the Penobscot Experimental Forest (PEF). These nine stands are grouped into three replicates of "triplets" (three plots) that are treated with light selection cutting (10% harvest, with many retention trees), moderate selection cutting (20% harvest, with some retention trees), or no cutting (i.e., control). These three replicates are all within one 1400 ha mixed-wood forest. My role in the FERP is to study how these treatments affect one aspect of biodiversity in the forest: breeding bird communities. Timber harvesting may change songbird species composition or territory densities for some species. Even if the community is similar after harvesting, a reduction in the rate that migratory songbirds reoccupy territories of previous years would indicate that logging has a detrimental effect on breeding productivity.

PROJECT STATUS: I surveyed songbird territories and marked individuals on all FERP research sites during the summer of 1995, before any site had been harvested. The first triplet was harvested during the following winter. Field work continued for three subsequent summers, ending after summer 1998; the last triplets had been harvested in previous winter (i.e., 1997-98). Using 100 mistnets and averaging 4,000 net-hours per summer, I captured and banded approximately 300 birds each summer from 1995-1998; nearly half the birds were individually colormarked. Return rates varied during the three sampling periods, being much higher in one year for both species. Preliminary return rates for Ovenbirds ($n = 111$) have consistently averaged 60% per year, whereas Hermit Thrushes ($n = 143$) average 70%. These estimates are higher than those reported in the literature, probably because many investigators fail to include recapture probability in survival estimates. Territory mapping data have shown very few changes in songbird communities due to harvest activities. Year-to-year variations in bird densities were much stronger than

differences between treatments and controls. There is evidence that these fluctuations may have been driven largely by predator (i.e., red squirrel) population dynamics during the study.

FUTURE PLANS: Statistical analyses began in 1999 and should be finished during 2001.

DEVELOPMENT AND APPLICATION OF OBSERVATION-BASED TECHNIQUES FOR ASSESSING FOREST SONGBIRD NESTING SUCCESS

Investigator: C. R. Foss

Advisors: M. L. Hunter, Jr., Chairperson
W. A. Halteman
W. B. Krohn
R. J. O'Connor
R. S. Seymour

*Cooperators/
Project
Support:* University of Maine
Switzer Environmental Fellowship Program
McIntire-Stennis
U.S. Fish and Wildlife Service -
Lake Umbagog National Wildlife Refuge
Neotropical Migratory Bird Program
USDA Forest Service
N.H. Fish and Game Department
Maine Department of Inland Fisheries and Wildlife
N.H. Department of Resources and Economic Development
Division of Forests and Lands
Boise Cascade
Mead Corporation
James River Corporation
Crown Vantage, Inc.
Maine Bureau of Public Lands
Seven Islands Land Company
Wagner Forest Management, Ltd.
Audubon Society of New Hampshire

Objectives:

- 1) Assess the effectiveness of reproductive index ranking of territories and fledgling surveys as indices of nesting success in forests.
- 2) Identify any behavioral biases that may skew reproductive index ranks for particular species.
- 3) Determine the relative effectiveness of sampling points and transects in fledgling surveys.
- 4) Determine effective sampling radii for fledglings.
- 5) Determine appropriate seasonal and diurnal periods for fledgling surveys.
- 6) Assess effects of partial cutting in spruce-fir forests on species composition, abundance, and nesting success of breeding bird communities using behavior mapping and reproductive index ranking.

SCOPE: Recent concerns about the relationships between forest fragmentation, harvesting practices, and biological diversity have increased the need for data on avian distribution, abundance, and productivity in forested landscapes. Recent population declines of some songbird species, notably some neotropical migrants, have underscored the need to understand patterns of reproductive success for forest songbirds. Selection management has been championed by some conservation groups as an alternative to clearcutting, which provides for both timber and wildlife habitat needs while minimizing ecosystem disturbance. Research has yet to address many important questions about impacts of

selection harvests on native wildlife.

This study explores the potential for observation-based survey techniques to provide relatively cost-effective indices to avian nesting success in forested habitats, and uses a combination of established and newly developed field survey techniques to study relationships between cutting intensity in spruce-fir stands and species composition, abundance, and nesting success of forest birds.

PROJECT STATUS: Pilot field work during May-August 1994 involved surveys on 12 20-ha plots in northern New Hampshire, 4 each in managed hardwoods, spruce-fir forest, and regenerating clearcuts. Surveys included a modified spot-mapping method, which focused on observations of breeding behaviors, and point and transect surveys, which focused on detection and identification of fledged young. Results led to the evolution of two techniques, behavior mapping for intensive surveys of rectangular study plots, and fledgling surveys for use in combination with point counts on linear transects.

The study of effects of partial cutting in spruce-fir forests began in 1995 on 11 20-ha plots in managed spruce-fir forests of the Androscoggin headwaters area of northern New Hampshire and western Maine. Treatments ranged from no cutting in the past 60 years through commercial thinning to progressively heavier partial cuts, conducted during the past 5-7 years. Field work conducted during May-August 1995 and 1996 involved behavior mapping of all birds encountered on the 11 plots. Vegetation surveys, including prism point sampling and collection of relevé data in each of 80 50x50 m-cells on each of the 11 plots, were completed during September-November 1996. Behavior mapping continued in 1997 on 6 of the 11 plots that spanned the range of silvicultural treatments. Comparisons of behavior mapping with nest-searching and monitoring were conducted on 10-ha subsets of 3 of the 11 plots in 1996, and of behavior mapping with constant-effort mist netting were conducted by a collaborator on a plot elsewhere in Maine in 1995 and 1996. This work was presented at a symposium, "Contemporary Research on the Effects of Forest Management on Bird Populations," during the Annual Conference of The Wildlife Society in Snowmass Village, Colorado, in September 1997, and have been submitted for publication with the symposium proceedings in the Wildlife Society Bulletin in early 1998.

FUTURE PLANS: Preparation of papers is the priority for the next academic year.

DIRECT EFFECTS OF GROUP SELECTION HARVEST GAPS ON THE BIRD COMMUNITY OF AN OAK-PINE FOREST

Investigator: S. P. Campbell

Advisors: M. L. Hunter, Chairperson
R. J. O'Connor
J. M. Rhymer
S. White
W. B. Halteman

*Cooperators/
Project
Support:* Holt Woodland Foundation
University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) Characterize the movement of breeding birds in the harvested and unharvested areas of the forest by examining:
 - a) forest canopy gap usage and avoidance
 - b) frequency and distance of territorial excursions.
- 2) Determine if territory sizes change in response to harvesting.
- 3) Investigate possible changes in bird behavior (e.g., changes in location of foraging, singing, nesting or resting).

SCOPE: Population declines in many species of Neotropical migrant birds have largely been attributed to the destruction and degradation of forest on their tropical wintering grounds as well as on their temperate breeding grounds. These findings have in turn drawn considerable attention to current forest management practices in both

tropical and temperate regions. Much of this attention has been given to the effects of clearcutting and fragmentation; however, few studies have examined the effects of small harvest-created openings or gaps in a forest.

One such study that is examining the effects of small harvest-created gaps on the forest bird community is being conducted at the Holt Research Forest in Arrowsic, Maine. The Holt Research Forest is the location of a long-term (16 years to date) oak-pine forest ecosystem study that was established with the broad goals of monitoring long-term changes in the forest's plant and animal community and documenting the effects of forest management practices on these communities. It was established in 1983 and after five years of baseline data collection on the entire 40-ha study area, one half of the area was harvested such that ten 1-ha blocks were partially cut with a group-selection timber harvest. The other half of the forest was left as an unharvested control. Data collection after the harvest has continued and results to date indicate that, in terms of abundance, some bird species (e.g., Black-throated Green Warbler, Ovenbird) have responded negatively to the gaps, some (e.g., Eastern Wood-Pewee, Common Yellowthroat, White-throated Sparrow) have responded positively, but the majority of the species have shown little to no effect.

My research will provide a closer examination of the effects of group selection created gaps on the bird community. In other words, I will look for effects beyond simple changes in abundance, which can be a misleading indicator of habitat quality, and focus on the more direct effects of the gaps. Specifically, I will be looking for alterations in movement patterns within and outside the territories of the birds, changes in territory size, and shifts in behaviors or locations of behaviors.

PROJECT STATUS: I have completed my second field season during which I mist-netted and banded 94 birds (127 captures), 78 of which I also colorbanded. The three species comprising most of the captures were Ovenbird (24%), Hermit Thrush (22%), and Black-throated Green Warbler (19%). The next most abundant species was Veery (7%). I recaptured 8 (12%) of the birds that I colorbanded in the previous year.

I recorded 137 locations of birds by resighting colorbanded birds in individually marked and mapped trees within the forest. Additional locations were estimated by triangulation of radiomarked birds. I also located 13 nests for which I recorded nest success.

Analyses of these data are underway and will be completed prior to the next field season.

PHILOPATRY AND DISPERSAL OF BLACK LEGGED KITTIWAKES (*Rissa tridactyla*) IN PRINCE WILLIAM SOUND, ALASKA

Investigator: T. M. Sauer

Advisors: J. R. Gilbert, Chairperson
W. E. Glanz
F. A. Servello

*Cooperators/
Project
Support:* U.S. Fish and Wildlife Service -
Migratory Bird Management
University of Maine -
Department of Wildlife Ecology

- Objectives:*
- 1) Determine philopatry and dispersal by cohort.
 - 2) Determine differences within and between cohorts of philopatric fledglings and evaluate movement patterns.
 - 3) Estimate demographic parameters including juvenile and adult local survival rates, age of first breeding and resighting probabilities.
 - 4) Evaluate the factors of colony size, colony growth, productivity, distance from, and direction to natal colony in explaining the observed pattern of dispersal.
 - 5) Quantify the error associated with local survival rate calculations.

SCOPE: Most information on Black legged Kittiwakes is based on data obtained from colonies in the Atlantic which may not be applicable to birds breeding in the Pacific Ocean. Preliminary data suggest that life history

strategies are geographically different. Prince William Sound, Alaska, contains 27 Black-Legged Kittiwake colonies. Data have been collected annually by the U.S. Fish and Wildlife Service on the number of nests and chicks at all colonies. Additionally, an intensive banding of chicks and resighting effort of adults has been done at the Shoup Bay colony since 1988 and 1991. Resighting efforts at all other colonies will allow natal dispersal of birds from the Shoup Bay colony to be estimated.

PROJECT STATUS: The data base of resighting information, banding information, nest locations, and plot information will be completed by December 1999. Field seasons to collect dispersal information were completed in 1997 and 1998 (additional information was collected in 1999). All requirements for the M.S. degree in Wildlife Ecology will be completed by Spring 2000.

WILDLIFE RESOURCES - OTHER THAN MIGRATORY BIRDS:

PREY SELECTION BY HARBOR SEALS IN RELATION TO FISH TAKEN BY THE GULF OF MAINE SINK GILLNET FISHERY

Investigator: A. S. Williams

Advisors: J. R. Gilbert, Chairperson
F. A. Servello
R. S. Steneck

*Cooperators/
Project
Support:* National Marine Fisheries Service,
BRD, USGS
University of Maine -
Department of Wildlife Ecology

Objectives:

- 1) Evaluate the diets of harbor seals caught in fishing nets.
- 2) Determine seasonal and spatial prey abundance and availability.
- 3) Estimate prey selection by harbor seals on commercial fish species.

SCOPE: The harbor seal (*Phoca vitulina*) is often accused of having negative effects on fishery yields in the northwestern Atlantic Ocean by preying on fish, damaging fish quality and tearing nets. Populations of seals in the Gulf of Maine have increased over the past twenty years. Potential loss of commercial fish to seals is a growing concern in the multispecies groundfish sink gillnet fishery. There is insufficient knowledge of the foraging ecology of seals to evaluate the effects of seal predation on the abundance of commercial fish stocks.

I will quantify the diets of harbor seals that were accidentally killed in gillnets. I will compare the food habits data, spatially and temporally, with quantities of available prey species and prey size.

PROJECT STATUS: All requirements for the Masters degree (in Wildlife Ecology) were completed in December 1999. The abstract follows:

As harbor seal (*Phoca vitulina concolor*) populations increase and commercial groundfish stocks dwindle in the Gulf of Maine, it is important to investigate the potential for competition between seals and fishermen. I aged 261 harbor seals from teeth or body measurements and identified prey from the stomach contents of 75 harbor seals caught in sink gillnets in the Gulf of Maine and adjacent waters from 1991 to 1997. Ninety three percent of seals caught in gillnets were less than four years old. Of 24 taxa identified, silver hake (*Merluccius bilinearis*) was found frequently (70.6% of stomachs), making up 52.1% of the prey items, and 40.8% of the reconstructed biomass. Silver hake, red hake, white hake, Atlantic cod, squid, and redfish (in IRI rank order) accounted for 77.7% of the reconstructed biomass and 87.4% of the number of prey consumed. Species richness was greatest in summer in northern Gulf of Maine diets (16 species) but more evenly distributed in winter in southern Gulf of Maine diets (13 species). Harbor seals utilized 11 of 22 commercial fish species landed by gillnet fishermen. Using the odds ratio with proportions of mass caught in sink gillnets and proportions of mass in the seal diets taken from the same nets, harbor seals selected silver hake, Atlantic herring, red or white hake, pollock, redfish,

and Atlantic cod. Dogfish, monkfish, skates, American lobster, and flounder were among some species selected against by harbor seals. The mean length of prey was 22 cm. Harbor seals selected small, juvenile silver hake, red hake, white hake, Atlantic cod, pollock, and redfish compared to those taken in gillnets. The species and size composition of prey taken by harbor seals differed significantly from sink gillnet catches. Predation by these predominantly juvenile harbor seals had a minimum effect on fish populations targeted by the sink gillnet fishery and seals were not in direct competition with fishermen.

INFLUENCE OF PARTIAL TIMBER HARVESTING ON AMERICAN MARTEN AND THEIR PRIMARY PREY IN NORTHCENTRAL MAINE

Investigator: A. K. Fuller

Advisors: D. J. Harrison, Chairperson
W. J. Jakubas
J. M. Rhymer
R. S. Seymour

*Cooperators/
Project
Support:* Maine Cooperative Forestry Research Unit
Maine Department of Inland Fisheries and Wildlife
Maine Agricultural and Forest Experiment Station

Objectives:

- 1) Document stand-scale patterns of habitat selection by marten whose home ranges have been influenced by selection harvesting and compare to patterns of habitat selection of marten in areas without selection harvesting.
- 2) Estimate small mammal and snowshoe hare densities in selectively harvested stands and compare with mature and regenerating forest stands.
- 3) Document and compare overstory, understory, and coarse woody debris characteristics between selectively harvested stands and mature forest stands.

SCOPE: Silvicultural practices in northern forests are shifting from a reliance on clearcutting (residual basal area < 6.9 m²/ha) to an emphasis on partial harvesting (residual basal area > 6.9 m²/ha). For example, partial overstory removal (residual basal area > 6.9 m²/ha) composed 94% of the total acreage harvested in Maine during 1999. The influence of partial harvesting on marten (*Martes americana*) habitat selection at the stand scale has been studied little, and the influence of partial harvesting on marten in a landscape matrix where extensive areas of regenerating clearcuts occur is speculative. Thus, I investigated the responses of marten at the sub-stand, stand-, and landscape-scales to predict the influences of large-scale partial harvesting on marten habitat quality, and evaluated current forest management objectives for marten.

Choice of forest stands by marten is also associated with food abundance and availability. Thus, I compared small mammal and snowshoe hare (*Lepus americanus*) densities in partially harvested stands to mature and regenerating forest stands, and related to habitat use by marten.

PROJECT STATUS: All requirements for the Masters degree (in Wildlife Ecology) were completed in December 1999. The abstract follows:

To determine the responses of marten to partial harvesting, I investigated habitat selection, home-range characteristics, and indices to performance for 18 marten that occupied home ranges with > 10% partial harvest in an industrial forest landscape.

At the stand scale, marten selected mature (>9 m tree height) forest types and partial harvests (13 m²/ha residual basal area, 52 - 59% basal area removal), and against young forests (3.1 - 6.0 m tree height) during summer (1 May - 31 October). Marten exhibited lower relative preference for partial harvest stands, and selected for mature forest types during winter (1 November - 30 April). Home-range areas of marten increased during winter to include a greater proportion of mature forest and less partial harvest. Increased home-range area during winter suggests that partial harvest stands are of reduced habitat quality relative to uncut, mature second-growth stands during the winter.

Reduced use of partial harvest stands during winter may result from overhead canopy closure <30%, which

may increase risks of avian and mammalian predation. Additionally, snowshoe hare are an important prey item for marten during winter, and partial harvest stands had the lowest density of hares among 5 overstory types. Densities of hare were greatest in regenerating clearcut stands, and least in partially harvested stands; densities were negatively associated with overstory canopy closure and density of coniferous trees, and positively associated with density of coniferous saplings (height < 1.5 m).

Partial harvest stands with basal areas of approximately 13 m²/ha support densities of small rodents comparable to mature mixed forest types, and thus contain sufficient densities of voles and mice to receive use by marten at the stand-scale during the summer. Densities of red-backed voles (*Clethrionomys gapperi*) were greatest in mixed and partial harvest stands, and least in regenerating stands that had been clearcut 15 -16 years previously. Deer mice (*Peromyscus maniculatus*) were most abundant in partial harvest and deciduous stands, while combined numbers of deer mice, red-backed voles, and shrews (*Blarina brevicauda* and *Sorex cinereus*) were greatest in partial harvest stands.

I suggest that partial harvest stands be positioned within a mature forest mosaic to provide for seasonal shifts in home ranges of marten. Harvested stands should retain basal areas > 18 m²/ha and canopy closure > 30% during winter. Partial harvests should be managed to promote advance coniferous regeneration and coniferous saplings, with an objective of maintaining similar densities of snowshoe hare as found in mature mixed stands.

FACTORS AFFECTING NESTING SUCCESS OF THE EASTERN WILD TURKEY IN CONNECTICUT: NEST ATTENTIVENESS, VEGETATIVE COVER, AND LANDSCAPE CHARACTERISTICS

Investigator: S. M. Spohr

Advisors: F. A. Servello, Co-Chairperson
D. J. Harrison, Co-Chairperson
J. R. Longcore
J. M. Ringo

*Cooperators/
Project
Support:* National Wild Turkey Federation -
Connecticut Chapter
Wildlife Forever
University of Maine -
Department of Wildlife Ecology
Connecticut Department of Environmental Protection -
Wildlife Division

Objectives:

- 1) Determine if nest success is influenced by attentiveness of hen turkeys.
- 2) Examine the effects of landscape characteristics on success and rates of predation on nests of wild turkeys in eastern Connecticut.
- 3) Determine the relationship between vegetative cover and the fate of turkey nests in eastern Connecticut.

SCOPE: In northern and midwestern regions of the U.S., winter mortality has been reported as one of the most important variables affecting eastern wild turkey (*Meleagris gallopavo silvestris*) populations. However, previous studies have concluded that winter mortality may not influence turkey populations in southern New England. Instead, annual population fluctuations of turkeys in New England are thought to result from variable reproductive success. Thus, nest success appears to be the most important demographic variable influencing annual population change of turkeys in this region. High annual variation in nest success is common, but the relative importance of environmental and behavioral factors that may affect nest success is not known. Our objectives are to determine the relative effects of nest attentiveness, cover, weather, and landscape characteristics on nest success of wild turkeys in Connecticut.

PROJECT STATUS: Fifty-nine wild turkey hens were captured and equipped with radio transmitters in the winters of 1996 and 1997. Hens were monitored daily during the reproductive season to determine timing of incubation and to

quantify and identify sources of mortality. A Rustrak recorder was set up near 16 nests to monitor hen activity and attentiveness to her nest. After hatching or abandonment, 48 nests were examined to determine clutch size and hatching success. Vegetative cover was measured in a 10-meter radius around each nest to determine habitat differences between successful and unsuccessful nests. Landscape characteristics (e.g., edge, developed land, agricultural land, patch density) were quantified at several scales using vector-based geographic information systems (ArcInfo and MapInfo) to determine differences between successful and predated nests.

FUTURE PLANS: Field work has been completed and data analysis is proceeding. Thesis completion is anticipated in December 2000.

SPATIAL AND TEMPORAL PATTERNS OF HAUL-OUT USE BY BREEDING HARBOR SEALS

Investigator: N. Guldager

Advisors: J. R. Gilbert, Chairperson
W. B. Krohn
J. T. Kelley

*Cooperators/
Project* National Marine Fisheries Service
Maine Forest and Agriculture Experiment Station
Support: University of Maine-
Department of Wildlife Ecology

Objectives:

- 1) Evaluate spatial and temporal patterns of haul-out use by breeding harbor seals.
- 2) Examine the effects of time of year, tidal phase, time of day, and weather conditions on haul-out use by breeding harbor seals.

SCOPE: The harbor seal (*Phoca vitulina*) is the most common pinniped that is found off the Maine coast. In late May and early June, harbor seals come inshore to have their pups on the many islands and intertidal ledges that scatter the coastline. Easily accessible, undisturbed rocky ledges of gentle slope and vegetative covering are often used. Researchers have found in various different geographic regions that annual timing of pupping, tidal phase, time of day and weather conditions have an effect on the proportion of seals hauled out. It is important to understand the effect of these covariables on haul-out numbers in Maine in order to obtain a precise population estimate from aerial surveys.

Aerial surveys have been conducted for the Maine coast during the pupping period in 1981, 1982, 1986, 1993, and 1997, during which all hauled-out seals and pups were counted within two hours on either side of low tide. These counts represent a minimum population estimate. The average annual rate of increase in the counts since 1981 has been 4.2 percent. Minimum number of seals observed in June 1981 was 10,543 and 30,990 in June of 1997. Estimated pup production has increased from 676 individuals in June 1981 to 5,359 individuals in June of 1997.

I will examine spatial and temporal patterns of haul-out use by mother/pup pairs during the pupping period and potential environmental factors affecting use in Penobscot and Blue Hill Bays, Maine. I also will document breeding phenology and investigate the effects of tide, time of day and weather conditions on haul-out numbers in a smaller area of Penobscot Bay (Muscle Ridges) during the pupping period.

PROJECT STATUS: Aerial surveys were completed in June 1997. The five years of census data have been georeferenced using a Geographic Information System (GIS). Environmental variables were calculated by use of a GIS as of October 1998. Field data on haul-out numbers, tidal phase, time of day and weather conditions were collected in the Muscle Ridges in May and June of 1998. Data were analyzed during 1999.

FUTURE PLANS: A thesis is being proposed and is under review by the committee. Project completion is scheduled for December 2000

BAT AND SMALL MAMMAL HABITAT RELATIONSHIPS IN THE INDUSTRIAL FORESTS OF NORTHERN MAINE

- Investigator:* S. C. Billig
- Advisors:* F. A. Servello, Chairperson
D. J. Harrison
W. E. Glanz
J. M. Hagan
- Cooperators/
Project
Support:* Manomet Center for Conservation Sciences
College of Natural Sciences, Forestry, and Agriculture -
Department of Wildlife Ecology
Plum Creek Timber Company
- Objectives:*
- 1) Determine relationship between coarse woody debris and small mammal abundance.
 - 2) Determine if upland buffer between clearcuts retain pre-harvest species assemblages of small mammals.
 - 3) Determine effects of forest and upland buffer edges on bat activity.

SCOPE: A difficulty in designing forested landscapes that maintain existing biological diversity in northern Maine is our poor understanding of how many species relate to managed forest habitats. The goal of this project is to better understand the relationships of small mammals, including bats, to habitat features in industrial forests of northern Maine. It has been hypothesized that small mammal abundance is related to coarse woody debris, but this hypothesis is relatively untested in the northeast. There is also little research on the value of separation zones for retaining small mammal species in harvested landscapes. I will examine microhabitat factors in relation to small mammal abundance and occurrence, with special emphasis on the importance of coarse woody debris and determine if separation zones, clearcuts, and continuous forest habitats maintain different small mammal species assemblages.

Overall, little is known about bats in northern New England except from research in New Hampshire, which indicates that bats need mature forests and linear edges, such as roads, for travel pathways. I will examine bat activity in relation to forest edge habitat in a heavily harvested area.

This project is being conducted in conjunction with the Shifting Mosaic Project, a forest research and management project of the Manomet Center for Conservation Sciences.

PROJECT STATUS: Both years of fieldwork have been completed. Small mammals were trapped on 45 sites, for the study of coarse woody debris. I will use microhabitat and forest structure data collected on these sites by Shifting Mosaic personnel. Small mammals were trapped in harvested buffers (n = 25), unharvested buffers (n = 5), clearcuts (n = 25), and continuous forest (n = 25), to evaluate species assemblages. Bat activity was surveyed using broadband ultrasonic bat detectors. Bat activity data were collected from clearcut-forest edges (n = 10), clearcut-buffer edges (n = 10), and clearcut center points (n = 10).

FUTURE PLANS: Data analysis and thesis writing are in progress. Project completion is scheduled for spring 2001.

A RETROSPECTIVE OF PRE-COMMERCIAL THINNING ON SNOWSHOE HARES AND SMALL RODENTS

Investigator: J. A. Homyack

Advisors: D. J. Harrison, Co-Chairperson
W. B. Krohn, Co-Chairperson

*Cooperators/
Project
Support:* Maine Cooperative Forestry Research Unit
National Council of the Paper Industry for Air and Stream
Improvement (NCASI)
U.S. Fish and Wildlife Service

Objectives:

- 1) Quantify and compare overstory, understory, coarse woody debris (CWD), and vertical and horizontal structure between herbicide treated clearcuts, with and without subsequent PCT, across a temporal gradient.
- 2) Document stand-level effects of PCT on densities of snowshoe hare and small mammals across a temporal gradient and relate to changes in vegetation associated with thinning.
- 3) Use existing data on forest structure and snowshoe hare densities from other forest types and silvicultural treatments in Maine to develop a predictive relationship of hare density in relation to overstory, understory, CWD, and structural variables.

SCOPE: In March 2000, the U.S. Fish and Wildlife Service listed the Canada lynx (*Felis lynx*) as a threatened species under the Endangered Species Act (ESA). Maine is the only state in the Northeast with a verified population of resident lynx. However, the relationships between lynx habitat and forestry practices are not well-studied. Lynx are a specialized predator, eating mostly snowshoe hare (*Lepus americanus*). Hares reach their highest densities in stands with exceptionally densities of conifer saplings. It is possible that extensive areas of regenerating forest, and the hare populations supported by these habitats, will turn out to be an important component of lynx habitat in Maine and that pre-commercial thinning (PCT) could be challenged as a habitat issue influencing lynx recovery. Thus, we are currently investigating the temporal effects of PCT on hare and small mammals in the industrial forests of northern Maine.

PROJECT STATUS: We established 24 small mammal grids on stands treated with PCT from four age classes, zero years since PCT (n=6), five years since PCT (n=6), 10 years since PCT (n=6), and 15 years since PCT (n=6). Thirteen small mammal grids were established on stands with similar site histories, but without subsequent PCT. We trapped mice, voles and shrews on all 37 grids during summer 2000. Trapping resulted in captures of 558 individuals. We completed microhabitat analysis of thirteen sites. We set up 1.6 km of snowshoe hare pellet transect in each of 30 stands for a total of 48 km of transect. A total of 2,520 pellet plots were distributed evenly among the 30 stands (n=84).

FUTURE PLANS: We will compare hare densities, small mammal densities, and structural characteristics of herbicided stands with and without PCT across a temporal gradient. A second year of field work will be conducted in summer 2001. Hare pellets will be counted and cleared in early spring and again in fall. We will verify the relationship between pellet density and hare density with live-trapping of hare. A second year of small mammal trapping will occur. We will complete microhabitat analysis and quantify stand characteristics.

INTERACTIONS BETWEEN HARBOR SEALS AND FINFISH AQUACULTURE IN MAINE

Investigator: M. Lucas

Advisors: J. R. Gilbert, Chairperson
F. A. Servello
J. R. Moring

*Cooperators/
Project
Support:* National Marine Fisheries Service
University of Maine Sea Grant Program
Maine Department of Marine Resources

Objectives:

- 1) To document the frequency and pattern of harbor seal predation at Maine fish farms in Maine;
- 2) To determine if this frequency and pattern is related to the number of harbor seals at nearby haul-outs; and
- 3) To determine if repeat attacks at a site are the result of the same seals or different seals.

SCOPE: The methods I intend to employ to satisfy each of the above objectives include: conducting personal interviews with site managers, reviewing available logs of predation events (i.e., from insurance companies) and personal observations; conducting aerial surveys of harbor seal locations and abundance within a 20 km 'swimming distance' of marine fish-farms; capturing harbor seals at finfish aquaculture facilities and haul-outs within 20 km distance and fitting said individuals with radio tags for the purpose of monitoring movements and documenting presence at finfish sites.

PROJECT STATUS: Additional funding support is being sought. University and Federal permits are pending.

FUTURE PLANS: The proposed research is anticipated to include two field seasons beginning in January of 2001. Data will be collected between the months of January 2001 - April 2001 and November 2001 - April 2002. Based on conversations with salmon growers and other industry members in Maine, winter is when seal predation is most prevalent at finfish aquaculture facilities.

Data analysis and writing of the thesis will be conducted following the field season of 2002.

HARBOR SEAL AND GRAY SEAL BEHAVIOR ON A SHARED HAUL-OUT SITE (MOUNT DESERT ROCK) IN THE GULF OF MAINE

Investigator: S. C. Renner

Advisors: J. R. Gilbert, Chairperson
W. E. Glanz
F. A. Servello
S. K. Todd

*Cooperators/
Project
Support:* College of the Atlantic-
Allied Whale
University of Maine

Objectives:

- 1) Compare behavior patterns of harbor seals and gray seals on Mount Desert Rock, including aggressive encounters, resting, and non-resting behaviors as a function of tide cycle, species composition on the haul-out ledge, and animal density
- 2) Determine environmental factors (tide, time of day, sea-state, or cloud cover) that influence haul-out patterns for both species of seals, and
- 3) Evaluate differences in haul-out site characteristics between ledges used primarily by gray seals and those used by harbor seals.

SCOPE: The number of gray seals (*Halichoerus grypus*) in the Gulf of Maine has been increasing for more than 20 years. Substantial data exist that quantify overlap of food resources for gray seals and harbor seals (*Phoca vitulina*), but few researchers have observed both species on common haul-out sites. Hauling-out serves several important functions for most phocids including rest between foraging forays (thus fat storage), predator avoidance, and molting. This project will address inter- and intra-specific interactions that may affect haul-out duration, location,

and function.

PROJECT STATUS: One year of field work was completed in 2000.

FUTURE PLANS: A second field season is scheduled for 2001. The thesis will be written, presented, and defended by December 2001.

CONSERVATION GENETICS OF THE PENOBSCOT MEADOW VOLE

Investigator: J. M. Lowry

Advisors: J. M. Rhymer, Chairperson
W. E. Glanz
F. A. Servello

*Cooperators/
Project
Support:* University of Maine
Department of Wildlife Ecology

Objectives:

- 1) To reanalyze morphologic characteristics of insular subspecies of meadow vole (*Microtus pennsylvanicus*), focusing on *M. p. shattucki* but also including the other island subspecies from southern New England through Canada.
- 2) To quantify morphological and genetic variation within and among extant populations of *M. p. shattucki* and the nominant mainland species.

SCOPE: The Penobscot meadow vole (*Microtus pennsylvanicus shattucki*) is an insular subspecies inhabiting Islesboro, North Haven, and TumbleDown Dick island in Penobscot Bay, Maine. It is one of a suite of island meadow vole subspecies that have been described from southern New England through Canada. Subspecific status of these populations was primarily based on univariate analysis of a few morphological variables comparing island and mainland populations. I am studying island populations of *M. Pennsylvanicus* in the Gulf of Maine: in particular, those of Islesboro and North Haven, the type localities of *M. p. shattucki*. The islands of coastal Maine have been separated from the mainland for 11,500 years, which may have been sufficient time for differentiation of *M. p. shattucki* from the nominant species. On the other hand, meadow voles have extraordinary dispersal capabilities, so continuous gene flow is possible from the mainland to near island populations. I will quantify the morphological and genetic variation among island and mainland populations to determine whether there is sufficient evidence for a distinct subspecies in Maine.

PROJECT STATUS: The research proposal has been approved by the committee, the first field season has been completed, and genetic analysis has started.

FUTURE PLANS: Genetic analysis will continue, museum specimens will be prepared from field season specimens and the morphological analysis of the specimens will start.

**PUBLICATIONS, THESES AND DISSERTATIONS
PROFESSIONAL AND PUBLIC TALKS GIVEN, AND AWARDS**

SCIENTIFIC PUBLICATIONS

- ALLEN, A. P., and R. J. O'CONNOR. 2000. Hierarchical correlates of bird assemblage structure on northeastern U.S.A. lakes. Environmental Monitoring and Assessment 62: 15-37
- ALLEN, A. P., T. R. WHITTIER, D. P. LARSEN, P. R. KAUFMANN, R. J. O'CONNOR, R. M. HUGHES, R. S. STEMBERGER, S. S. DIXIT, R. O. BRINKHURST, A. T. HERLIHY, and S. G. PAULSEN. 1999. Concordance of taxonomic composition patterns across multiple lake assemblages: effects of scale, body size, and land use. Canadian Journal of Fisheries and Aquatic Sciences 56: 2029-2040.
- BANK, M. S., W. L. FRANKLIN, and R. J. SARNO. 2000. Assessing the effect of radiocollars on juvenile guanaco survival. Oecologia 124(2): 232-234.
- BARTLETT, J. G., D. M. MAGEEAN, and R. J. O'CONNOR. 2000. Residential expansion as a continental threat to U.S. coastal ecosystems. Population and Environment 21: 429-468.
- BOONE, R. B., and W. B. KROHN. 2000. Predicting broad-scale occurrences of vertebrates in patchy landscapes. Landscape Ecology, 15(1): 63-74. [Part of a special peer-reviewed issue on Gap Analysis for Landscape Conservation].
- BOONE, R. B., and W. B. KROHN. 2000. Partitioning sources of variation in vertebrate species richness. Journal of Biogeography 27:457-470.
- BOONE, R. B., and W. B. KROHN. 2000. The vegetation transition zone and bird ranges in Maine. Journal of Biogeography 27:471-482.
- DeMAYNADIER, P.G., and M.L. HUNTER, JR. 2000. Road effects on amphibian movements in a forested landscape. Natural Areas Journal 20(1): 56-65.
- DITCHKOFF, S. S., and F. A. SERVELLO. 2000. Sampling recommendations for assessing deer undernutrition by analysis of urine in snow. Wildlife Society Bulletin 27:1004-1009.
- HUNTER, M.L. 2000. Refining normative concepts in conservation biology. Conservation Biology 14:573-575.
- LAMOTHE, P. J., M. GALLAGHER, D. P. CHIVERS and J. R. MORING. 2000. Homing and movements of yellow phase American eels in freshwater ponds. Environmental Biology of Fishes 58: 393-399.
- LOFTIN, C. S., W. RASBERRY, and W. M. KITCHENS. 2000. Development of a grid-cell topographic surface for Okefenokee Swamp, Georgia. Wetlands 20(3): 487-499.
- McCRACKEN, K., M.L. HUNTER, JR., and J. WITHAM. 1999. Relationships between seed fall of three tree species and *Peromyscus leucopus* and *Clethrionomys gapperi* during ten years in an oak-pine forest. Journal of Mammalogy 80:1288-1296.
- MORING, J. R. 2000. The creation of the first public salmon hatchery in the United States. Fisheries 25(2): 6-12.
- O'CONNOR, R., M. T. JONES, R. B. BOONE and T. B. LAUBER. 1999. Linking continental climate and land

use patterns with grassland bird distribution in the conterminous United States. Studies in Avian Biology 19:45-59.

O'CONNOR, R. J. 2000. Expert systems, fuzzy logic, and coral reef development under environmental stress. Conservation Biology 14:904-906.

O'CONNOR, R. J., T. E. WALLS, and R. M. HUGHES. 2000. Using multiple taxa to index the ecological condition of lakes. Environmental Monitoring and Assessment 61: 207-229.

SARNO, R.J., W.R. CLARK, M.S. BANK, W.S. PREXL, W.E. JOHNSON, M.J. BEHL, and W.L. FRANKLIN. 1999. Juvenile guanaco survival: management and conservation implications. Journal of Applied Ecology 36(6):937-945.

SERVELLO, F. A., and J. S. SCHNEIDER. 2000. Evaluation of urinary indices of nutritional status of white-tailed deer: tests with winter browse diets. Journal of Wildlife Management 64:137-145.

WHITE, A.S., J.W. WITHAM, M.L. HUNTER, JR., and A.J. KIMBALL. 1999. Relationship between plant species richness and biomass in a coastal Maine Quercus-Pinus forest. Journal of Vegetation Science 10:755-762.

TECHNICAL AND SEMI-TECHNICAL PUBLICATIONS

ABER, J., N. CHRISTENSEN, I FERNANDEZ, J FRANKLIN, L HIDINGER, M. HUNTER, J. MACMAHON, D. MLADENOFF, J. PASTOR, D. PERRY, R. SLANGEN, and H. MIEGROT. 2000. Applying ecological principles to management of the U.S. National Forests. Issues in Ecology No. 6, Ecological Society of America, Washington, D.C. 20pp.

BANK, M. S., and A. F. O'CONNELL, JR. 2000. Stalking salamanders in Acadia National Park. Natural New England 1(4): 8-9.

FULLER, A. K., and D. J. HARRISON. 1999. Influence of selection harvesting on American marten and their primary prey in northcentral Maine. Pp. 17-20 **In** Cooperative Forestry Research Unit 1999 Annual Report. Maine Agricultural and Forest Experiment Station Miscellaneous Report 417, and Maine Cooperative Forestry Research Unit Information Report No. 44, University of Maine, Orono, ME.

FULLER, A. K., and D. J. HARRISON. 2000. Influence of partial timber harvesting on American marten and their primary prey in northcentral Maine. Miscellaneous Report, Maine Cooperative Forestry Research Unit, University of Maine. 46pp.

GILBERT, J. R. 2000. The effect of seals on Maine Atlantic salmon. College of Natural Sciences, Forestry and Agriculture White Papers, Series 3: Maine and the Atlantic salmon. 2pp.

HARRISON, D. J. 1999. Response of wildlife to thinning in forests of the northeastern U.S. Pp. 35-40 **In** Thinning in the Maine Forest Conference Proceedings, Augusta, ME.

HEPINSTALL, J. A., S. A. SADER, W. B. KROHN, R. B. BOONE, and R. I. BARTLETT. 1999. Development and testing of a vegetation and land cover map of Maine. Maine Agriculture and Forest Experiment Station, Technical Bulletin 173, University of Maine, Orono. 104pp.

KROHN, W. B., R. B. BOONE, S. A. SADER, J. A. HEPINSTALL, S. M. SCHAEFER, and S. L. PAINTON. 1998 (2000). Maine Gap Analysis – a geographic analysis of biodiversity. Two CD's published by the USGS Biological Resources Division, Gap Analysis Program, Moscow, ID. (For sale by the Maine Department of Inland Fisheries and Wildlife, Augusta).

- KROHN, W. B., and J. A. HEPINSTALL. 2000. A habitat-based approach for identifying open-space conservation needs in southern Maine. Final Contract Report to Maine Department of Inland Fisheries and Wildlife, Augusta, Maine. 36pp. plus appendices.
- MORING, J.R. 2000. Atlantic salmon restoration, rehabilitation, and Federal protection. College of Natural Sciences, Forestry White Papers, Series 3: Maine and the Atlantic salmon. 2pp.
- MORING, J. R. 2000. The role of hatchery fish: a Maine view. The Maine Sportsman 251 (July 2000): 72-74.
- O'CONNOR, R. J. 2000. Letter: "Women and awards." The Scientist 14(1): 4, January 10, 2000.
- O'CONNOR, R. J., E. DUNN, D. H. JOHNSON, S. L. JONES, D. PETIT, K. POLLOCK, C. R. SMITH, J. L. TRAPP, and E. WELLING. 2000. A programmatic review of the North American Breeding Bird Survey: report of a peer review panel. Report to Patuxent Wildlife Research Center, Laurel, MD.
(www.pwrc.usgs.gov/bbs/bbsreview/bbsfinal.pdf)
- PAYER, D. C., and D. J. HARRISON. 1999. Effects of timber harvesting and trapping on population characteristics, habitat selection, and area occupancy by American martens in northern Maine: the Baxter Perk Study Site. Pp. 14-16 In Cooperative Forestry Research Unit 1999 Annual Report. Maine Agricultural and Forest Experiment Station Miscellaneous Report 417, and Maine Cooperative Forestry Research Unit Information Report No. 44, University of Maine, Orono, ME.
- PAYER, D. C., and D. J. HARRISON. 2000. Influences of timber harvesting and trapping on habitat selection and demographic characteristics of marten. Miscellaneous Report, Maine Cooperative Forestry Research Unit, University of Maine. 67 pp.
- RHYMER, J.M. 1999. Genetic markers for analysis of wildlife biodiversity. College of Natural Sciences, Forestry and Agriculture, Biotechnology White Paper Series. 2pp.
- WITHAM, J., M. HUNTER, H. TEDFORD, A. KIMBALL, A. WHITE, and S. GERKEN. 1999. A long-term study of an oak-pine forest ecosystem: A brief overview of the Holt Research Forest. Maine Agricultural and Forest Experiment Station Miscellaneous Publication 745. 23 pp.

THESES AND DISSERTATIONS

- COMPTON, B. W. 1999. Ecology and conservation of the wood turtle (*Clemmys insculpta*) in Maine. M. S. Thesis, University of Maine, Orono. 91pp.
- FULLER, A. K. 1999. Influence of partial timber harvesting on American marten and their primary prey in northcentral Maine. M. S. Thesis, University of Maine, Orono. 141pp.
- GUERRY, A. D. 1999. Effects of landscape pattern on amphibian species assemblages in an agriculturally-fragmented landscape. M. S. Thesis, University of Maine, Orono. 115pp.
- HOFFMAN, T. A. 2000. Food habits of splake (*Salvelinus namaycush* x *S. fontinalis*) in the presence and absence of landlocked salmon (*Salmo salar*): assessment of potential competition. M.S. Thesis, University of Maine, Orono. 63 pp.
- LE, J. B. C. 1999. Movements of brook trout, *Salvelinus fontinalis*, at Hunter's Brook, Acadia National Park, Maine. M.S. Thesis, University of Maine, Orono. 78pp.

LEAMAN, N. G. G. 1999. Mercury contamination in the silver stage of American eels, *Anguilla rostrata*, from three rivers in Maine. M. S. Thesis, University of Maine, Orono. 37pp.

STONE, J. 2000. Association between fall emigration and spawning activity in lake populations of brook trout (*Salvelinus fontinalis*) of Mount Desert Island, Maine. M. S. Thesis, University of Maine, Orono. 93pp.

WILLIAMS, A. S. 1999. Prey selection by harbor seals in relation to fish taken by the Gulf of Maine sink gillnet fishery. M. S. Thesis, University of Maine, Orono. 59pp.

ZIEL, H. L. 2000. Phylogeography and mating systems of American Woodcock. M. S. Thesis, University of Maine, Orono. 72pp.

PROFESSIONAL TALKS PRESENTED

BANK, M. S. 1999. "Effects of maternal defense on survival of juvenile guanacos in southern Chile." Animal Behavior Discussion Group, Department of Biological Sciences, University of Maine, November 20, 1999.

BANK, M. S. 2000. "Survival of juvenile guanacos in southern Chile: conservation implications." Oral presentation presented at the Spring 2000 Maine State Chapter of The Wildlife Society, Brewer, ME, April 27, 2000.

BANK, M. S., and W. L. FRANKLIN. 2000. "Selection of copulation sites by guanacos in Torres del Paine National Park, Chile." Oral presentation presented at the 80th annual meeting of the American Society of Mammalogists, June 17-21, 2000, University of New Hampshire, Durham, NH.

BARTLETT, J. G., R. J. O'CONNOR, and D. M. MAGEEAN. "Residential expansion as a threat to desert ecosystems in the United States." Session on Spatial Demographics, 30th Annual Meeting of the Southern Demographics Association, San Antonio, TX, October 22, 1999.

BARTLETT, J. G., J. MOORE, D. M. MAGEEAN, and R. J. O'CONNOR. "Modeling human-environment interaction at the local scale." Poster presented at the 15th Annual Symposium of U. S. Regional Association of the International Association for Landscape Ecology: Integration of Societal and Landscape Heterogeneity: Problems and Solutions. Fort Lauderdale, FL, April 18, 2000.

FROST, H. C., and W. B. KROHN. "Post-natal growth and development of fishers (*Martes pennanti*)." Presentation at the 3rd International *Martes* symposium - *Martes* 2000 *Martes* in Managed Landscapes. Corner Brook, NF, August 16, 2000.

FULLER, A. K., H. J. LACHOWSKI, and D. J. HARRISON. "Responses of mammals at two trophic levels to partial harvesting." Paper presented at 80th Annual Meeting of the American Society of Mammalogists, University of New Hampshire, Durham, NH, June 19, 2000.

FULLER, A. K., and D. J. HARRISON. "Influence of partial harvesting on habitat selection by American marten in an industrially forest landscape." Paper presented at 3rd International *Martes* Symposium, Corner Brook, NF, August 14, 2000.

FULLER, A. K., H. J. LACHOWSKI, and D. J. HARRISON. "Stand-level responses of American marten and prey to forest management: do marten respond to distribution of prey?" Paper presented at 3rd International *Martes* Symposium, Corner Brook, NF, August 15, 2000.

GARMAN, G. C., and J. R. MORING. "A fifteen-year reassessment of a stream ecosystem in Maine after salvage cutting." Paper presented at the Annual Meeting of the American Fisheries Society, St. Louis, MO, August

23, 2000.

- GERKEN, S.A., and J. WITHAM. “*Peromyscus leucopus* and *Clethrionomys gapperi* abundance cycles during 17 years in a Maine oak-pine forest.” Paper presented at 80th Annual Meeting American Society of Mammalogists, Durham, NH, June 20, 2000.
- GILBERT, A., and F. A. SERVELLO. “Factors limiting populations of black terns in Maine.” Maine Bird Conference, Falmouth, ME, May 5, 2000.
- GILBERT, J. R. “Seals in the Western Atlantic.” U. S. Atlantic Salmon Assessment Committee Annual Meeting. Invited presentation, Gloucester, MA, March 6-7, 2000.
- GILBERT, J. R. “Estimation of walrus population numbers.” Invited presentation at the Pacific Walrus Survey Workshop, Anchorage, AK. U. S. Fish and Wildlife Service and Biological Resources Division, U.S.G.S., March 6, 2000.
- HAHN, C., and R. J. O’CONNOR. “Scaling of host and environmental patchiness in the distribution of Brown-headed Cowbirds.” Paper presented at Conference on “Predicting Species Occurrences: Issues of Scale and Accuracy, Snowbird, UT, October 19, 1999.
- HARRISON, D. J. “Effects of thinning on wildlife habitat.” Invited paper presented at Conference on Thinning in the Maine Forest, Augusta, ME, November 15, 1999.
- HARRISON, D. J. Served as Program Chair and provided opening comments for 3rd International *Martes* Symposium, Corner Brook, NF, August, 14, 2000.
- HARRISON, D. J., D. PAYER, A. FULLER, J. HEPINSTALL, and D. KATNIK. “Landscape thresholds and response to fragmentation by American marten.” Paper presented at 3rd International *Martes* Symposium, Corner Brook, NF, August, 14, 2000.
- HARRISON, D. J. Served as chairperson for session titled: Planning and managing landscapes for *Martes*, 3rd International *Martes* Symposium, Corner Brook, NF, August, 14, 2000.
- HARRISON, D. J. Served as an invited panelist for discussion of: What is suitable habitat for North American *Martes* 3rd International *Martes* Symposium, Corner Brook, NF, August 15, 2000.
- HARRISON, D. J. Chaired plenary session titled: Status of *Martes* and their habitats from a global perspective, 3rd International *Martes* Symposium, Corner Brook, NF, August 15, 2000.
- HARTLEY, M. “Biodiversity in managed forests: plantations.” Forestry Seminar Series, University of Maine, Orono, October 15, 1999.
- HARTLEY, M. “Effects of selective silviculture on songbird breeding communities.” Seminar given at the Department of Natural Resource Sciences, McGill University, Quebec, Canada, October 20, 1999.
- HEPINSTALL, J.A., W.B. KROHN, and S.A. SADER. “Effects of population status and niche width on the performance of avian habitat models.” Poster presented at conference on “Predicting Species Occurrences: Issues of Scale and Accuracy, Snowbird, UT, October 19, 1999.
- HEPINSTALL, J.A., and W. B. KROHN. “Use of predicted vertebrate occurrences in regional land conservation planning.” Paper presented at the 14th Annual Conference of the Society for Conservation Biology, Missoula, MT, June 11, 2000.

- HOVING, C. L., and W. B. KROHN. "Spatial and temporal variation of snowfall across the northeastern U. S. A. and eastern Canada." Poster presentation at the Third International *Martes* Symposium. Corner Brook, NF, Canada, August 13-16, 2000.
- HUNTER, M.L., JR., and M. HARTLEY. "Conserving biodiversity in natural and plantation forests." University of Maine Department of Wildlife Ecology Forestry Noontime Seminar Series, October 15, 1999.
- HUNTER, M.L., JR. "The biological dynamics of landscapes." Keynote address at the Modeling Forested Landscapes and Wildlife Workshop, Cloquet, MN, November 4, 1999.
- HUNTER, M.L., JR. "Natural processes as models for managing ecosystems." Talk presented to Biology Department, University of Minnesota, Duluth, November 5, 1999.
- HUNTER, M.L., JR. "The biological dynamics of landscape." Talk presented to National Catholic University of Chile, Santiago, Chile, December 15, 1999.
- HUNTER, M.L., JR. "Jewels in the crown: Vernal pools as a mesofilter approach to conserving regional biodiversity." Paper presented at Vernal Pools of the Northeast Conference, University of Rhode Island, Kingston, RI, April 1, 2000.
- HUNTER, M.L., JR. "The biological dynamics of landscapes." Talk presented to University of Maine Wildlife Ecology Department, April 26, 2000.
- HUNTER, M.L., JR. "The biological dynamics of landscapes." Talk presented to University of Port Elizabeth, South Africa, August 14, 2000.
- HUNTER, M.L., JR., and A.J.K. CALHOUN. "Vernal pools and a mesoscale filter approach to maintaining biodiversity." Society for Conservation Biology. Missoula, MT, June 11, 2000.
- JOHNSON, C.M., and W.B. KROHN. "Temporal changes in island use by breeding seabirds: empirical evidence that long-term occupancy data are essential." Paper presented at conference on "Predicting Species Occurrences: Issues of Scale and Accuracy, Snowbird, UT, October 19, 1999.
- KROHN, W.B., C.L. HOVING, D.J.HARRISON, D.M. PHILLIPS, and H.C.FROST. "*Martes* foot-loading and snowfall distribution in eastern North America: implications to broad-scale distributions and mesocarnivore interactions." Presentation at the 3rd International *Martes* Symposium - *Martes* 2000, Corner Brook, NFDL, August 14, 2000.
- LAWLER, J., R. O'CONNOR, and J. G. BARTLETT. "Natural and anthropogenic correlates of butterfly and bird species richness." Presented a paper at the 15th Annual Symposium of U S Regional Association of the International Association for Landscape Ecology: Integration of Societal and Landscape Heterogeneity: Problems and Solutions, Fort Lauderdale, FL, April 18, 2000.
- O'CONNOR, R. J. The spatio-temporal structuring of avian distributions. Plenary paper presented at Conference on "Predicting Species Occurrences: Issues of Scale and Accuracy, Snowbird, UT, October 19, 1999.
- PAYER, D. C., and D. J. HARRISON. "Influence of forest structure on habitat use by American marten." Paper presented at 10th Northern Furbearer Conference, Fairbanks, AK, April 17, 2000.

- PAYER, D. C., and D. J. HARRISON. "Effects of timber harvesting and trapping on demographic characteristics of marten." 10th Northern Furbearer Conference, Fairbanks, AK, April 18, 2000.
- PAYER, D. C., and D. J. HARRISON. "Demographic characteristics of American marten in relation to clearcutting and trapping." Paper presented at 3rd International *Martes* Symposium, Corner Brook, NF, August 14, 2000.
- PAYER, D. C., and D. J. HARRISON. "Effects of timber harvesting and trapping on habitat selection by American marten." Paper presented at 3rd International *Martes* Symposium, Corner Brook, NF, August 15, 2000.
- PAYER, D. C., and D. J. HARRISON. "Territoriality and home-range fidelity of American marten in relation to timber harvesting and trapping." Paper presented at 3rd International *Martes* Symposium, Corner Brook, NF, August 16, 2000.
- PERKINS, D. W., W. G. SHRIVER, and P. D. VICKERY. "The effects of fire on the breeding ecology of Florida Grasshopper and Bachman's sparrows." Annual Meeting for Northeast Wildlife Graduate Student Conference, Acadia University, Wolfsville, NS, Canada, February 27, 2000.
- PERKINS, D. W. "Breeding Ecology of Florida Grasshopper and Bachman's sparrows." University of Maine Wildlife Ecology Seminar Series, Orono, ME, March 6, 2000.
- PERKINS, D. W. "Breeding Ecology of Florida Grasshopper and Bachman's sparrows." USFWS Region 5, Vero Beach, FL, March 21, 2000.
- RHYMER, J., M. WILLIAMS, and R. KINGSFORD. "Phylogeography and subspecific status of the Grey Duck, *Anas superciliosa* in New Zealand and Australia: is special protection warranted in New Zealand?" Southern Hemisphere Ornithological Congress, Griffith University, Brisbane, Australia, June 29, 2000.
- RHYMER, J.M. "Molecular genetics and conservation biology: studies at the University of Maine." NSF EPSCoR Conference, University of Maine, Orono, ME, October 19, 1999.
- RHYMER, J.M. "What do the new molecular genetic techniques mean?" Maine Department of Inland Fisheries & Wildlife, Bangor, ME, January 20, 2000.
- SCHAEFER, S., and W.B. KROHN. "Predicting vertebrate occurrences from species habitat associations: improving the interpretation of commission error rates." Poster presented at conference on "Predicting Species Occurrences: Issues of Scale and Accuracy, Snowbird, UT, October 19, 1999.
- WITHAM, J. "Long-term trends of butterfly infestation in white-footed mice." Paper presented at American Society of Mammologists, Durham, NH, June 21, 2000.
- ZIEL, H.L., D. MCAULEY, and J.M. RHYMER. "No multiple paternity in American Woodcock (*Scolopax minor*)." Meeting of American Ornithologists' Union, Canadian Ornithological Society, & British Ornithological Society, St. John's, NF, Canada, August 16, 2000.

PUBLIC TALKS PRESENTED

- BANK, M. S. "Survival of juvenile guanacos in southern Chile." Presented at the 1999 Wildlife Society Student Chapter Fall Seminar Series, University of Maine, Orono, ME, October 25, 1999.
- BANK, M. S. "Quantifying species diversity." Guest lecturer in Statistical Ecology (WLE 220). University of

- Maine, Orono, ME, February 2, 2000.
- BANK, M. S. "Wildlife of Torres del Paine National Park: portrait of a United Nations Biosphere Reserve." Eagle Hill Evening Seminar Series, Humboldt Field Station, Steuben, ME, September 5, 2000.
- BANK, M. S. "Career opportunities in wildlife ecology/Patagonia wildlife field studies." Guest lecturer in Introduction to Wildlife Resources (WLE 100). University of Maine, Orono, ME, September 11, 2000.
- BILLIG, S. C., and F. A. SERVELLO. "Habitat relationships of small mammals and bats in the industrial forests of western Maine." Presentation to the Stakeholder Council of the Shifting Mosaic Project, Orono, ME, May 9, 2000.
- BILLIG, S. C. "Evaluation of two forest management practices recommended for small mammals: buffer strips and retention of coarse woody debris." Shifting Mosaic Field trip for Plum Creek foresters. Kibby and Skinner townships, ME, September 20, 2000.
- FULLER, A.K. "*Peromyscus* and Hantavirus." Invited lecture in Ecology (WLE 200), University of Maine, Orono, October 26 and 28, 1999.
- FULLER, A.K. Getting started in wildlife. Invited lecture in Introduction to Wildlife Resources (WLE 100), University of Maine, Orono, November 15, 1999.
- FULLER, A. K. "Influence partial timber harvesting on American marten and their primary prey in northcentral Maine." M. S. Thesis Seminar, Department of Wildlife Ecology, University of Maine, Orono, December 2, 1999.
- GILBERT, J. R. Testimony to Board of Environmental Protection on the effects on seals of building a dock, Mount Desert Island, August 7, 2000.
- HARRISON, D. J. Presented a proposal to study effects of precommercial thinning on wildlife to Cooperative Forestry Research Unit, Bartlett, NH, October 12, 1999.
- HARRISON, D. J. Presented a seminar of "Final results of 10 year study on effects of forest harvesting and trapping on American martens" to Advisory Committee, Cooperative Forestry Research Unit, University of Maine, Orono, ME, February 2, 2000.
- HOFFMAN, T. A. "Potential food competition between splake and landlocked salmon." Presentation to the statewide Fisheries Division meeting, Maine Department of Inland Fisheries and Wildlife, Orono, ME, November 20, 1999.
- HOVING, C. "The Canada Lynx Issue in Maine." Invited lecture in State Chapter meeting of the Society of American Foresters, Augusta, ME, May 30, 2000.
- HUNTER, M.L. "A naturalist tour of Chile." Maine Audubon Society, Orrington, Maine, April 5, 2000.
- KROHN, W. B. "Establishing land conservation priorities for Maine." After dinner slide presentation at annual meeting of the Maine Association of Land Trusts, Wasscasset, ME, May 5, 2000.
- LOFTIN, C. S. "Assessing effects of forest practices on headwater streams in Maine: literature synthesis, location of streams using DEM data, and spatial assessment of forested riparian landscapes in Maine." Invited Proposal Presentation to the Cooperative Forest Research Unit, University of Maine, Quarterly Meeting, Wells Conference Center, Orono, ME, February 2, 2000.

- LOFTIN, C. S. "Detecting ecological impacts: applications of the environmental impact assessment process." Invited presentation to the University of Maine Student chapter of The Wildlife Society, Orono, ME, March 6, 2000.
- LOFTIN, C. S. "Applications of GIS in management of public lands." Invited presentation to the Wildlife Habitat Relationships class, Department of Wildlife Ecology, University of Maine, Orono, ME, April 24 & 26, 2000.
- MORING, J. R., and J. MAGEE. "Atlantic salmon: the past, present, and future." Eagle Hill/Humboldt Field Research Institute Seminar Series, Steuben, ME, July 27, 2000.
- O'CONNOR, R. J. "Spatio-temporal structuring of avian distributions." Invited lecture for Department of Wildlife and Fisheries Sciences Seminar, Texas A&M University, College Station, TX, April 13, 2000.
- PAYER, D. C. "Influences of timber harvesting and trapping on habitat selection and demographic characteristics of marten." Ph.D. Dissertation Seminar, Department of Wildlife Ecology, University of Maine, Orono, June 14, 2000.
- PERKINS, D. W. "Grassland birds of Maine." Maine Audubon Society, Holden, ME. October 6, 2000.
- PERKINS, D. W. "Grassland birds of Maine." Wildlife Ecology 100, University of Maine, Introduction to Wildlife Resources, Orono, ME. November 8, 2000.
- SERVELLO, F. A. "Population and habitat studies of black terns in Maine: 1997-1999." Talk given at the Department of Wildlife Ecology Seminar series, December 13, 1999.
- SERVELLO, F. A. "Research on the endangered black tern of Maine." Talk to the Penobscot County Conservation Association, Brewer, ME, February 3, 2000.
- SERVELLO, F. A. "Ecology of tern in Maine." Talk to the Sebasticook River Watershed Association, Unity College, Unity, ME, April 5, 2000.
- SERVELLO, F. A. "Population ecology of black terns in Maine." Talk to the Student Chapter of the Wildlife Society, University of Maine, April 10, 2000.
- STONE, J. "Spawning movements of brook trout of Mount Desert Island, Maine." Presentation to the statewide Fisheries Division meeting, Maine Department of Inland Fisheries and Wildlife, Orono, ME, April 24, 2000.
- WITHAM, J. Conducted a forest ecology research field trip for members of the Maine Chapter of The Nature Conservancy at the Holt Research Forest, October 2, 1999.
- WITHAM, J. "Preserving the Bay: the Thorne Head experience." Talk given to Friends of Merrymeeting Bay at Bowdoin College, Brunswick, ME, October 20, 1999.

WORKSHOPS

- GILBERT, J. R. Atlantic Scientific Review Group meeting of National Marine Fisheries Service and US Fish and Wildlife Service, Woods Hole, MA, November 4-5, 1999.

GILBERT, J. R. NOAA Strategic Planning Workshop. Participant, Washington DC, February 9-11, 2000.

GILBERT, J. R. IFAFS Funding Panel. Participant, CREES/USDA, Washington DC, July 16-19, 2000.

O'CONNOR, R. USFWS Round Table on "Critical Habitat and the Endangered Species Act", Reston, VA, February 8, 2000.

O'CONNOR, R. Meridian Institute: Round Table on Sustainable Forestry Workshop on "Criteria and Indicators for the Montreal Process, Denver, CO, March 12-15, 2000.

O'CONNOR, R. Proposed Pilot Census of Marine Life in the Gulf of Maine and Georges Bank Ecosystem. Attended workshop at the Woods Hole Oceanographic Institution, Woods Hole, MA, May 2-3, 2000.

AWARDS, HONORS, AND APPOINTMENTS

HARRISON, D. J. 1999-2000 G. Peirce and Florence Pitts-Webber Award to the Outstanding Researcher in Forest Resources, University of Maine; promoted to Professor, Department of Wildlife Ecology, University of Maine; appointed as a Cooperating Scientist, Maine Cooperative Forestry Research Unit; appointed as Cooperating Professor, Department of Forest Ecosystem Science, University of Maine; appointed as Program Chair, 3rd International *Martes* Symposium.

HUNTER, M.L., JR. Distinguished Wildlife Alumnus Award, Department of Wildlife Ecology, University of Maine, Orono, ME.

MORING, J. R. Appointed to the Symposium Review Committee and the Contributed Papers Review Committee for the Annual Meeting, American Fisheries Society; elected Northeastern Division Representative to the Nominating Committee, American Fisheries Society; Appointed to the Membership Committee, American Institute of Fishery Research Biologists.